THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL,

VOL. 26. Thursday, July 6th, 1922. No. 307.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
BESSEMER HOUSE, 5, DUKE STREET, ADELPHI,
LONDON, W.C.2.

Contents.

	PAGE
Foundry Apprenticeship Courses	1
Notes from the Branches	1
Correspondence	2
The British Empire Exhibition	4
New Methods of Testing Cast Iron	5
New Pig-Breaker	12
Personal	12
The Preparation of Moulding Sand	13
Moulding a Trunk Casting in Loam	15
Foundry Ladles	16
Classes in Foundry Work at Leicester	16
Intermediate Cylinder Heads for Vertical Gas Engines	17
Correspondence	18
Book Review	18
National Physical Laboratory	19
Trade Talk	20
Cupola Melting Tests with Mixtures Changing During Run	20
Company News	20
Iron and Steel Markets	21
Gazette	22
Deaths	22

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE

INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institution of British Foundrymen.

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Foundry Apprenticeship Courses.

We are continually being consulted as to the arranging of foundry classes, and we have decided that the best way of showing our practical sympathy with our correspondents is to submit a series of articles, each one of which would form a separate lecture. This work has been entrusted to Messrs. Ben Shaw and James Edgar, who are already known to our readers as regular contributors to our columns. We propose to start this series in our issue of July 20. This will give managers ample opportunity of arranging for extra supplies of the journal for their apprentices. This question is especially important in districts which are so situated that a foundry class is ruled out of court. We wish it to be clearly understood that the patternmaking end of foundry work will be dealt with just as fully as the moulding. We invite correspondence on any point which is not clear or requires amplification. If any are of general interest, they will be published, together with an answer. The instruction given will not be confined merely to iron founding, as the non-ferrous side will receive equal consideration.

The success of the competitions at the International Foundry Exhibition, recently held at Birmingham, amply demonstrated that there are numbers of youths who *do* take interest in their craft. They only need encouragement. The proprietors of THE FOUNDRY TRADE JOURNAL will foster, by every means possible, this awakened interest in foundry matters, and will arrange for a reduction in the price of the Journal to firms who have the interest of their apprentices sufficiently at heart to take a number for their benefit. Additionally, when the series is completed an examination will be organised, and prizes will be awarded. We would remind ambitious foundry youths that last year we organised a competition for the best design for a modern foundry, and the winner of the second prize publicly announced that this fact helped him to gain an important appointment in India. People who have jobs to give, consider not so much the actual gaining of any prize or award but rather the time spent in amassing the requisite knowledge. As for the proprietors and managers they are bound to gain much, for it is a *sine qua non* that an ambitious apprentice is an asset to his firm.

Whilst on this subject of foundry apprentices, we can assure them that they are the managers of the future. The metallurgist, too, has excellent prospects in the foundry, but he can never, without working on the floor and at the bench, gain the requisite knowledge to manage adequately the foundry of the future. He is always, more or less, in the hands of his foreman, a position which will become untenable as time goes on. We ask our readers to make this clear to the lads under them, by assuring them that future management will be in their hands and not in those of the theoretically trained student, except in rare cases.

Notes from the Branches.

Newcastle Branch.

In spite of the high cost of railway travelling, a good number of all grades of North of England members turned up at the Convention in Birmingham. The meeting, both as regards business and social, is declared to be a high success, and the President, together with the Reception Committee, are to be highly congratulated on a very successful and interesting week.

General satisfaction is felt in the Branch at the election of Mr. R. O. Patterson, of Wylam, as Junior Vice-President, and a Newcastle Convention is being looked forward to with keen interest.

Congratulations to Mr. Edmund J. Rang on passing the final B.Sc. examination in engineering at Durham University.

Owing to so many of the Northern members having attended the Convention, the usual summer outing has been abandoned this year.

We extend hearty congratulations to all those members who entered the competitions at the Exhibition, and to those firms who paid their employees' expenses for seeing the Exhibition and entering the competitions. As several of the competitors were successful in winning prizes and recognition of their work, these enterprising firms and competitors will have every cause to feel satisfied.

Correspondence.

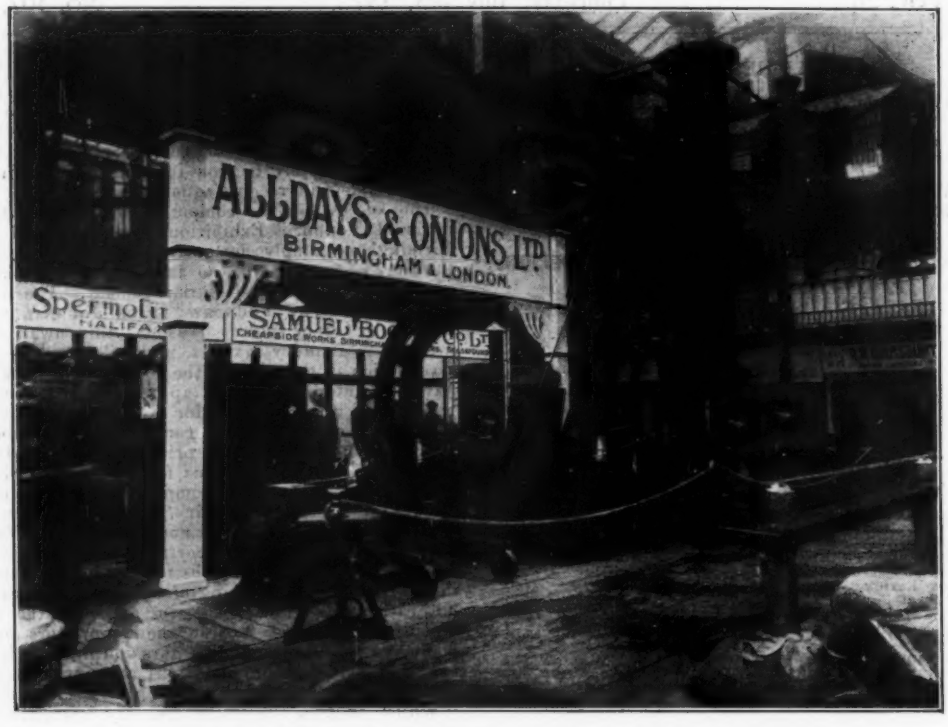
[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

An Appreciation.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Will you kindly allow a small space in *our* Journal for us to express our thanks and appreciation to the proprietors of THE FOUNDRY TRADE JOURNAL for their forethought and kindness in providing the beautiful Cottage at the Birmingham Exhibition last week? It was the one refreshing and restful spot, amidst the moil and toil of an exceedingly busy and noisy show. But for this Cottage, the stalls would not have been visited as many times as they were, for, after resting awhile, one could easily make another tour of the Exhibition. Again, we tender our thanks, especially to our host, who was most persistent in bringing in the weary wanderers to rest and refresh themselves.—Yours truly,

A WEARY ONE.



A CORNER OF THE INTERNATIONAL FOUNDRY TRADES' EXHIBITION.

A TYPICAL VIEW IN THE INTERNATIONAL FOUNDRY TRADES' EXHIBITION.

The Birmingham Conference.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Now that the 1922 Conference of the Institution of British Foundrymen and the Birmingham

Exhibition is over we can look back and sum up the whole proceedings, and decide its value. In the first place, our best thanks are due to the Birmingham Branch and the Conference Committee, not only for the very excellent programme provided, but for the clock-like precision in which it was carried out, to the education and enjoyment of all. Looking back on the previous Conferences one is apt to wonder how they were carried out so splendidly, with so little material at the disposal of the then organising committees.

It is undoubtedly a sure sign of the value and importance and future success of the I.B.F., when with such trade depression existing, and everybody more or less is experiencing lean times, that the Birmingham Branch and its Conference Committee should have been able to collect sufficient material to make the whole proceedings so marked a success. Again, our best thanks to them.

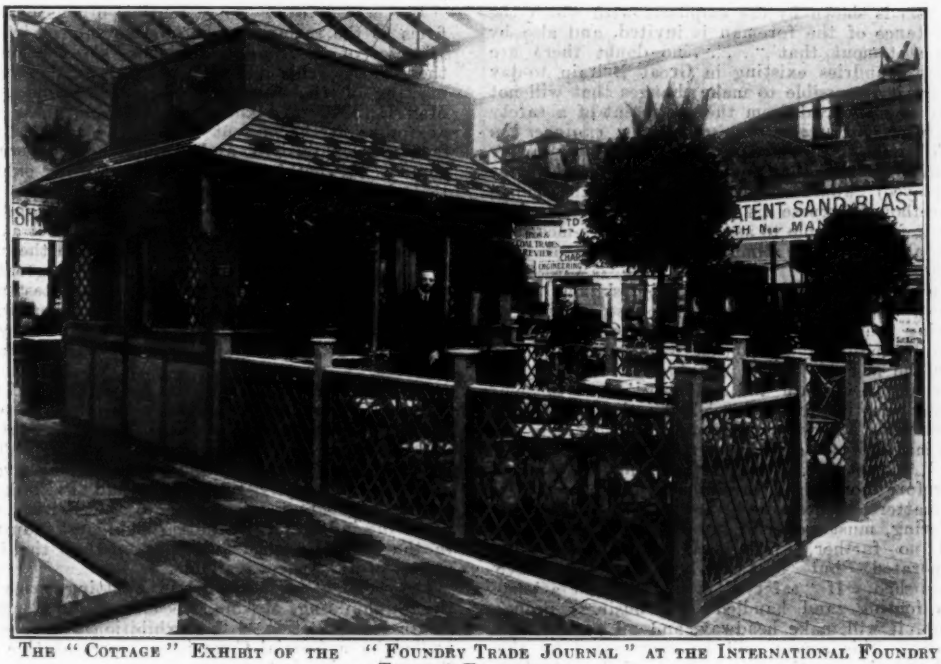
ONE WHO ENJOYED ALL.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—As one who has attended nearly all the Conferences of foundrymen, one can realise all the difficulties that arise in organising them. One can admire the splendid work done by the Birmingham Branch and its committees, and the satisfactory results obtained. One does not wish to add one single note of discord, but after spending four days at the Exhibition, and roughly comparing those who had the I.B.F. badge with those who had not, one was inclined to think that much excellent propaganda work could have been undertaken and many new members obtained for the Institution if the Organising Committee had secured a stand for the I.B.F., where any could have obtained full particulars of membership, etc. It was a grand opportunity lost. However, it is to be hoped the future organising committees will endeavour to remember this side of the Institution's work.—Yours, etc.,

OLD STAGER.

THE MODEL FOUNDRY.—THE INTERNATIONAL FOUNDRY TRADES' EXHIBITION.



THE "COTTAGE" EXHIBIT OF THE "FOUNDRY TRADE JOURNAL" AT THE INTERNATIONAL FOUNDRY TRADES' EXHIBITION.

Safety Work in Foundries.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The Paper read before the Birmingham Conference of the Institution of British Foundrymen on "Safety Work in Foundries" contains one clause which, in the opinion of the writer, will not be universally concurred with, viz.: "One of the human instincts (inherent in every person) is to avoid pain and suffering. The spring of human sympathy is just as deep and pure among employers as it is among the employees: therefore, surely every member of the Institution of British Foundrymen is seeking the best methods, and the best way, to place his plant among the 100 per cent. record of no accidents."

It may be that the desire to believe in this prompted the utterance, for the human instinct to avoid pain and suffering is confined (in industry, at all events) to the welfare of self, and not to the welfare of associates. In other words, the man looks after number one, and if by so doing he confers benefits upon others, this is merely incidental, and not the result of sympathy on the others' behalf.

In making this statement the writer does not wish it to be inferred that this is an attack upon industrial employers, and still less an attack upon those employers associated with the foundry industry, for whilst there is plenty of evidence to show that the endeavours of the employers to "avoid pain and suffering" are largely influenced by the conviction that accidents are detrimental to efficiency, there is as much evidence to show that the efforts of the individual are likewise dictated by matters of self-interest.

It may be that to-day we are more enlightened, and that in the past our natural instincts have been repressed by our inability to give practical expression; still, it is the writer's opinion that present-day activity in the direction of "safety work" is the outcome of business acumen rather than of the instincts of humanity, and that further progress is dependent upon development in this direction.

That this view is shared to no little extent by the author of the Paper (who, incidentally, is a production engineer, and not a "Welfare engineer) is shown by the emphasis with which the assistance of the foreman is invited, and also by the statement that ". . . . no doubt there are many foundries existing in Great Britain to-day where it is possible to make changes that will not only be beneficial from the viewpoint of a safety engineer, *but from the production engineer as well*" (the italics are mine). The writer is far from suggesting that anyone (whether employer or employee) would deliberately and with malice aforethought expose his fellow to pain or suffering, but it is reasonable to assume that active measures for alleviation are stimulated by motives of self-interest.

In other words, greater activity is likely to be shown when the result shows promise of being a paying proposition, and if the employer is a keen business man, intent upon efficiency in every direction, he is more likely to achieve results in the "avoidance of pain and suffering" than the employer who is propelled solely by the dictates of humanity. And why? Because the former, viewing the matter from a business standpoint, goes "all out" to get a return for expenditure, and is therefore thorough in his methods, whilst the latter, no matter how desirous he is of alleviating human suffering, must sooner or later exclaim, "Thus far and no farther," not because his desire has evaporated, but because his resources have diminished. If "safety" is placed upon a business footing, and handled as a business proposition, it will make headway, and all parties will benefit. This aspect will be appreciated by the workman, because he can understand it, but when he is approached in the spirit of, "My good man, I am sincerely desirous of helping you, and I am introducing certain methods solely for your benefit," the unspoken thought of the favoured one is, "And what are you going to get out of it?"

The slogan "No accidents to-day" is quite a good one, but, as admitted in the Paper, it is almost impossible to run a foundry without accidents, and in the circumstances the endeavour to live up to the slogan may mean the suppression by the men of a number of mishaps which, although trivial, may have far-reaching effects. Every effort should be made to encourage the men to report *every accident*, so that at the end of the week the notice may read, "Several accidents reported, but all of a trivial character."—Yours, etc.,

P. D.

The British Empire Exhibition (1924).

Shipbuilding, Marine, Mechanical and General Engineering Section.

As already announced, the British Engineers' Association has been entrusted with the task of organising and allotting space in the Shipbuilding, Marine, Mechanical and General Engineering Section of the British Empire Exhibition to be held in London in 1924.

A guarantee fund of £1,000,000 has been raised, the preparation of the site is already far advanced, and the erection of suitable buildings of the most modern construction has been commenced.

Wembley Park, the site of the Exhibition, is easily accessible from the provinces and every part of the Metropolis. It is only twenty minutes' railway journey from Charing Cross. Special train, tram and 'bus services will be organised on a liberal scale to meet the convenience of visitors.

The Exhibition will be representative of the great resources of the British Empire. The Dominion Governments, the Government of India, and our Colonies, Dependencies and Protectorates are actively participating in an effort to make the Exhibition worthy of its name.

No exhibition of such scope and importance has been held during the lifetime of the present generation. The industrial development of the British Empire is an urgent economic necessity, and the one great hope for the future of our race. The British Empire Exhibition will, therefore, be a great national event of which full advantage should be taken by the manufacturing industries of this country. It so happens that it will mark a period in which greater progress has been made in engineering than in any other branch of industry. The engineering firms must, therefore, see to it that their industry is properly represented.

We would draw the attention of engineering firms to the remarks made on this subject by the Director of the British Engineers' Association in the course of his address at the annual general meeting of the Association, held in London on May 11, 1922: "I know that many business men are prone at the present time to look with little favour on exhibitions, and it might be a debatable point as to whether this, that, or the other exhibition should or should not be held; but it is too late to deal with the British Empire Exhibition from that point of view. We must regard it as an Exhibition which is going to be held, and the only problem before us is how to make it the greatest possible success, and how to reap the greatest possible advantage from the opportunity of displaying the products of the British engineering industry to a very large number of important visitors from overseas.

"I hope that members of the Association and the industry generally will recognise the importance of the British engineering industry being adequately and creditably represented at this Exhibition. The Overseas Dominions have undertaken to play a very active part in this Exhibition, and I think it would be a great misfortune to the British engineering industry if it, the second biggest industry in the country, were not represented to the full extent of the space available."

The work of organising and allotting space in the Shipbuilding, Marine, Mechanical and General Engineering Section of the Exhibition will be controlled by a Special Committee representative of the engineering industry.

Within the limits of the space available—about 238,000 square feet—every effort will be exerted to make the engineering exhibits representative of all that is best in modern British practice. A form of provisional application for space is now available, and copies may be had on application to the Secretary, The British Engineers' Association, 32, Victoria Street, London, S.W.1.

In view of the anticipated large number of applications for space, and in order to enable the Committee to prepare a well-considered plan, early application is essential.

New Methods of Testing Cast Iron.*

By E. V. Ronceray, M.I.Mech.E. (Paris).

Presented on behalf of the French Association Technique de Fonderie.

In order to comply with the invitation of the Institution of British Foundrymen to present a Paper at the Birmingham meeting, the French Association Technique de Fonderie has thought it advisable to select a subject of world-wide interest—one referring to the research of two French scientists on new methods of testing cast iron. Both of them are well known in England. One of them, M. Fremont, received the Bessemer Medal at the Paris meeting of the Iron and Steel Institute in September last; the other, M. A. Portevin, is a Carnegie Medallist, and has sent quite a number of papers to the Iron and Steel Institute.

It seems as if a great deal of advancement can be expected in the foundry from the systematic use of such methods. They deserve to be carefully considered and tried.

In early times, the transverse test was used. As far back as 1790 the Ramus testing machine, known as the Monge machine, is described in the "Annales de Chimie."† The great scientist, Monge, described the machine and used it, and he was considered as the inventor. M. Ch. Fremont's research showed that the real inventor was Michel Ramus, manager of the Creusot Foundry. The bars were 80 mm. square and about 50 cm. long. They were supported by one end and loaded at the other end.

Fig. 1, taken from M. Fremont's memoir, shows the Ramus machine. This same machine‡ is described by Monge, who was thought to be its inventor, though Monge mentions the Creusot machine.

It is a very curious fact that though M. Fremont and many others consider at the present time that the transverse test is the ideal one, and that Monge test is still described in most French specifications, it has been practically abandoned

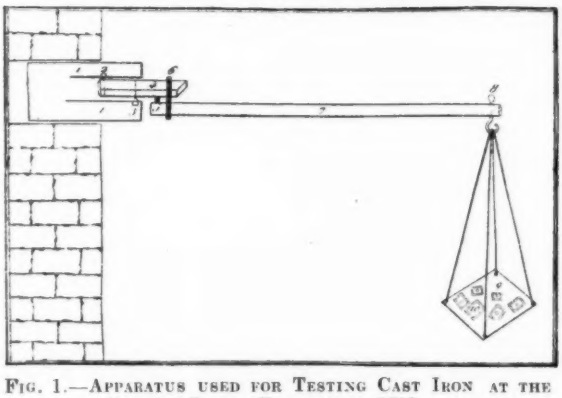


FIG. 1.—APPARATUS USED FOR TESTING CAST IRON AT THE CREUSOT ROYAL FOUNDRY IN 1790.

and replaced by two stupid tests, the tensile and the impact tests.

Colonel Prache, in his Paper before the French and Belgian Associations Convention at Liège, October, 1921, said:—"What has stopped the improvements to be made with semi-steel during the war are the tests imposed by the War Office. Those who have made semi-steel shells know that these tests had a very distant relation to the castings that were to be produced."

In America transverse tests have been made in the past on square or rectangular bars of all sizes and lengths. Great efforts have been made recently in that country to come to an agreement for a standard bar, and to impose it on other countries. A round bar 1¼ in. dia. was selected, and it was to be broken on supports 12 in. apart. But the pipe industry of U.S.A. uses a bar 2 in. × 1 in. placed flat on supports 24 in. apart, and the car-wheel men generally use the same, whilst many shops retain the old 1-in. square bar broken on supports 12 in. apart. Bars have been used with supports 3 ft. and even 5 ft. apart, while Keep experimented on bars ½ in. dia.

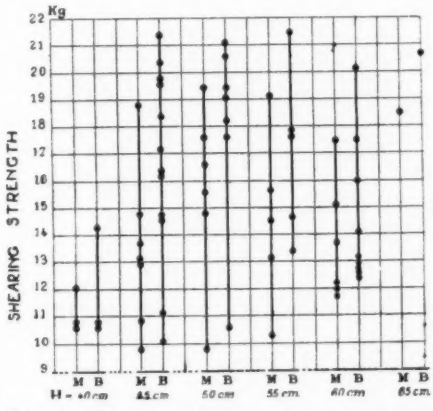


FIG. 2.—GRAPH SHOWING THE RELATIONSHIP BETWEEN SHOCK AND SHEAR TESTS. THE ABSCISSA GIVES HEIGHT OF DROP, AND THE ORDINATES THE CORRESPONDING RESISTANCE TO SHEARING. *M*, SHEAR TEST-PIECES TAKEN FROM CENTRE OF SHOCK TEST-PIECE. *B*, SHEAR TEST-PIECE TAKEN FROM THE EDGE OF THE SHOCK TEST-PIECE.

In England the standard test piece is usually a casting 3 ft. 6 in. long × 2 ft. deep × 1 in. wide, broken on supports 3 ft. apart.

In France, as mentioned, Monge tests have been practically superseded by the tensile and impact tests.

The impact test is made on a bar 40 mm. × 40 mm. × 200 mm. long. A weight of 12 kg. is

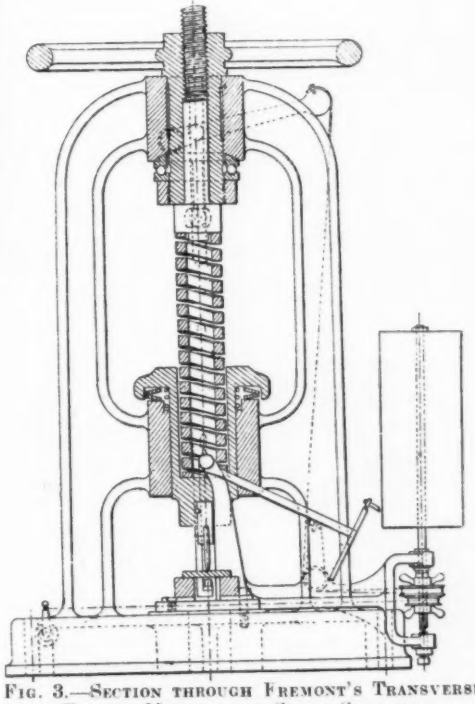


FIG. 3.—SECTION THROUGH FREMONT'S TRANSVERSE TESTING MACHINE FOR SMALL SAMPLES.

raised and dropped on the bar, which is set on supports 160 mm. apart. The initial height of weight is not the same in all specifications, nor the increase in height after each blow.

* A Paper read before the Birmingham Conference of the Institution of British Foundrymen.

† Ch. Fremont, "Nouvelles Methodes d'éssais Mécaniques de la Fonte," p. 11.

‡ "Description de l'Art de Fabriquer les Canons, Paris an II 1794)" p. 18.

The tensile test is made either on testing pieces 16 mm. or 25 mm. dia.

To demonstrate that the impact test is of no value, M. Fremont made transverse experiments with broken impact test-pieces, the results of which are shown in Fig. 2. For each set of bars having broken at a given figure, he made shear-tests on pieces taken on the middle and on the edge of the bars. The dots refer to shear-tests; M is for middle, and B for the edge of the bar. It can be seen that some of the bars which broke at a small height gave excellent tests, while the reverse happened with bars broken at a great height.

Colonel Prache was quite justified in stating that "War Office tests prevented foundrymen from making better shells," and M. Portevin that "On the point of view of the quality of metal for projectiles, it was difficult to make a worse choice of testing methods." It is quite easy to understand that to get the best results on different shell thicknesses different thicknesses of test-bars should be used.

But the best way would certainly be to ascertain the quality of castings on themselves rather than on test-bars more or less different from them, or next to that, on a small sample taken on one out of a lot of castings.

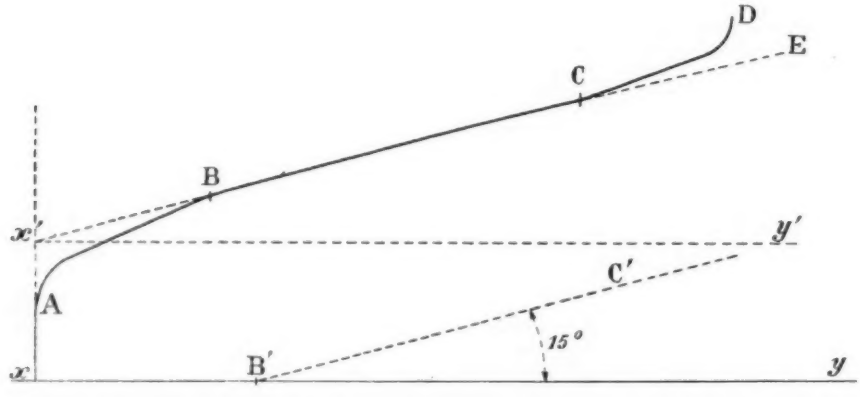


Fig. 4.—Diagram as produced and then corrected. Abscissæ gives the load, and the ordinates the corresponding deflection.

This is sufficient to condemn this test apart from other reasons.

Everybody is convinced that the tensile test is of no value for cast iron on account of its sensitiveness to an oblique pull. In fact, M. Portevin has demonstrated by the method of mirrors that it is entirely valueless when it is made under ordinary conditions. The same happens for hardened steel, which possesses similar characteristics.

The work of M. Fremont and M. Portevin refers to such methods, which in the author's opinion are the incentive to considerable progress in the foundry. Their methods will enable foundrymen to select the best composition of metals and the best foundry methods; they will enable the designer to alter his drawings according to the results shown by numerous readings taken in different parts of the castings.

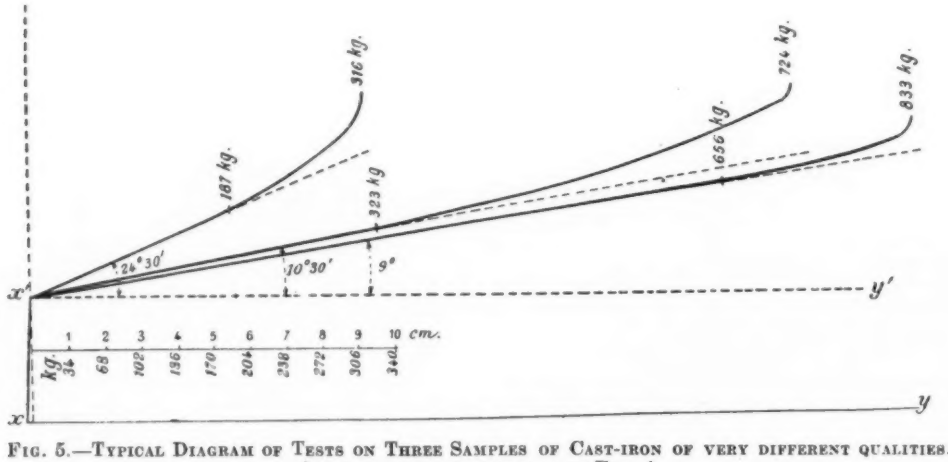


Fig. 5.—Typical Diagram of Tests on Three Samples of Cast-iron of very different qualities. Abscissæ and ordinates as in Fig. 4.

Tensile tests are accepted but not recommended in America; they are very little used in England and cut out of German specifications. The best French experimenters are of the opinion that it must not be used under ordinary conditions.

Cast-iron structure varies with the rate of cooling, and consequently the thickness of sample and condition of pouring. It seems almost unbelievable that, even in this time of progress and science, the qualities of cast iron have been observed on separately-cast test-bars which are entirely different in structure from castings. It is certainly very difficult to get from the same ladle of molten iron test-bars giving the same results, but what can be expected from a test-piece cast separately, of a thickness entirely different from the casting considered and generally cast at a different time.

The result will probably be to bring further confidence in cast iron, the products being more regular and reliable.

It would be a great advantage if such methods were submitted to a Committee composed of members of the various foundry organisations, in order not only to decide on the tests to be recommended, but also on the size of test-pieces, so that results of all foundries or investigators can be compared.

Fremont's Transverse Testing Machine.

To study the quality of a cast iron in the laboratory, M. Fremont recommends the static transverse test. But considering that the test had to be made on a sample taken from the castings, he designed a machine to deal with small samples. He also thought that it was necessary to record

the condition of the test. He selected the size of 10 mm. width × 8 mm. thick × 35 mm. long, so that a sample could be cut out of any portion of any casting in order to study all parts of it and arranged the machine with a recording apparatus.

This machine is shown in Fig. 3. To verify the practical value of the machine he made tests on 110 samples, for most of which he knew the practical value.

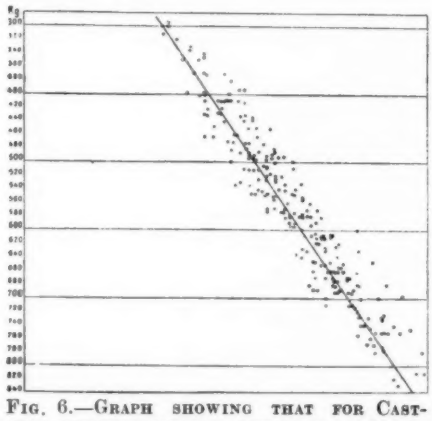


FIG. 6.—GRAPH SHOWING THAT FOR CAST-IRON THE RESISTANCE TO SHEARING IS PROPORTIONATE TO THE DEFLECTION. ABSCISSÆ TRANSVERSE BREAKING LOAD, AND ORDINATES CORRESPONDING SHEAR BREAKING LOADS.

The size of test-piece selected determined the maximum power of the machine. It is of 1,000 to 1,500 kgs. capacity, but this power must be applied gradually without any shock. The best device was thought to be a screw driven by a hand wheel, with the insertion, between the screw and the punch, of a large spring which transmits gradually, and without shock, the power of the screw.

The weight of moving equipment is balanced by a spring, resting in a groove of the machine-frame. The spring yields proportionally to the power applied at the ratio of 1 mm. for 43 kgs. The breaking of test-pieces takes place when the screw has made from 3 to 8 revolutions, according to the strength of the sample, which allows of a very simple and easy reading of the applied load. To measure the elastic limit and elastic coefficient, a recording apparatus is provided.

By a convenient arrangement a drum is moved by a metallic wire in connection with the large spring, so that 1 mm. corresponds to 3.4 kg. The deflection of the test-piece being very small, it must be amplified about 200 times.

Fig. 4 shows the diagram produced. The left part shows a curve, which is the result of the contacting a test-piece with the recording finger. The real starting point is x', x'y' being considered as the zero line. Where the line ceases to be straight, at C, the elastic limit is attained, and the angle C, x'y' gives the measure of the elastic coefficient.

The breaking is always sudden, on account of the nature of cast iron. To protect the recording apparatus from accident, two Belleville washers are placed under the tool holder; the stroke of the punch is then limited to 2 mm., and, in addition, a special arrangement is provided for the horizontal levers to avoid trouble when breaking of sample occurs.

The machine is gauged by measuring the deflection of the spring for a given load or by pressing with it on a scale. A similar process is used for the deflection of the test-piece, in using a Palmer caliper for pushing the levers.

Fig. 5 shows three typical diagrams corresponding to different qualities of cast iron arranged to permit comparison between them.

FIG. 8.—LEVER-ACTUATED MACHINE FOR SHEAR-TESTING CAST-IRON.

The first gave a breaking load of 316 kg. associated with an angle of 24 deg., 30 secs.; the second, a breaking load of 724 kg. with an angle of 10 deg., 30 secs.; whilst the third was 833 kg. with an angle of 9 deg.

It shows that the deflection has varied in the ratio of one to three. The elastic coefficient can be determined from the deflection record. The numerous experiments made by M. Fremont show that the stronger the iron the smaller is the deflection, while it does not vary much for the steel.

M. Fremont recommends this method for the study of the metal and conditions of specifications. For the inspection of castings he recommends the shearing test.

FIG. 7.—FROM LEFT TO RIGHT: TREPANNING TOOL—SAMPLE TREPANNED—TOOLS FOR BREAKING OFF—SAMPLE AFTER TREPANNING—SQUARE AND ROUND TEST-PIECES—CHISEL AND ITS ADJUSTABLE BLADE.

Shearing Tests.

The shear test has been devised in view of daily inspection of castings produced. In a previous work on steel, M. Fremont had been able to demonstrate that the phenomenon of shearing or punching was of the nature of tensile and not of slipping, as was supposed, each fibre of metal acting as a separate testing piece, which elongated under the pressure of the test.* He was able to show that, for steel, there was a direct relation between shearing and tensile strength.

To ascertain what was the case for cast iron he made experiments on the 110 samples he had used for the transverse tests. He found that shearing strength is in proportion to the transverse strength, as is shown in Fig. 6.† Other experiments have shown that tensile strength is equal to shearing strength for cast iron. Consequently, a shearing test is quite satisfactory for inspecting purposes, and, moreover, is not liable to the errors of tensile tests.

To judge the casting on itself, M. Fremont put forward the testing of either a square piece, 5 m/m × 5 m/m, cut out of the casting, or a round piece 5.64 m/m dia. drilled out of it, that is in every case 25 sq. mm.

This method was presented by him to the International Congress for Testing Methods, N.Y., 1912, and, criticising it, Dr. Moldenke said:‡

"Shearing pressure is applied to this rod, cutting off little pieces every $\frac{1}{8}$ in. and the average taken. The proposal is exquisite in its novelty and ingenuity."

It is often possible to cut off, on finished pieces, little prisms that can be machined to the size of 5 × 5 mm. But when this is not possible the same results are obtained by drilling with a hollow drill, a hole in some part where there will be later on an assembling hole, or to drill a hole in an unimportant part to be plugged afterwards, or else by sacrificing a casting.

The hollow drill is 10.5 mm. dia. with a hole 5.64 mm. dia., so that the small cylindrical piece remaining has 25 sq. mm. The detaching of test-piece is obtained by using a small special tool (Fig. 7) made up of two eccentric tubes fitted together, the inside of small tube being 5.64 mm. dia., and outside of large one 10.5 mm. dia. When the eccentricities are completing each other they are pushed inside the circular groove formed by the hollow drill, then turning the lever of external tube, while the inside one is held firmly, the piece is broken out.

The test-piece, either square or round, is then sheared, a figure being obtained by measuring the required load every $\frac{1}{8}$ in. to ascertain the strength of cast iron at different thicknesses. A test-piece 20 mm. long ($\frac{3}{4}$ in.), weighing 4 gr., is sufficient to take four readings; that is, 1 gramme per reading instead of several pounds. The shearing is effected through parallel and not oblique blades. There is one square and one round hole in the blades.

The machine for utilising the method is shown in Fig. 8. It will be slightly altered for rendering its use easier in practice. It is simply composed of a lever having a fixed point, with an arrangement to press on the blade by a weight moved alongside the lever. The weight is moved by a handle, pulling on the weight-roller, through a string (Fig. 9), but a hand-wheel and screw arrangement will be provided in future machines. Power is increased in relation to leverage; when the power corresponds to strength of sample, breaking occurs.

During the testing, a pencil is moving along a sheet of paper, giving a diagram similar to the one shown in Fig. 9. A table prepared according to the constants of the machine gives the strength of sample tested.

Of course, this shear test can be made on tensile testing-machines of corresponding power fitted with a shearing device, but it is thought that the little special machine described will be preferred by foundrymen on account of its simplicity and low cost.

It may be interesting to mention some results obtained by M. Fremont on an automobile engine on which he made numerous tests:—

	Tons per sq. in.
Inside of cylinder (tensile strength by shearing)	12·7—17·8
Outside of Water Jacket	12·0—14·6
Piston	10·6—13·0
Piston Rings	17·8—25·1

Of course an outside test piece would not have shown different strength for the same casting.

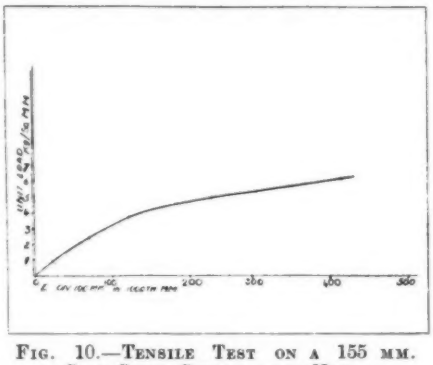


FIG. 10.—TENSILE TEST ON A 155 MM. SEMI-STEEL SHELL AT ITS NOSE.

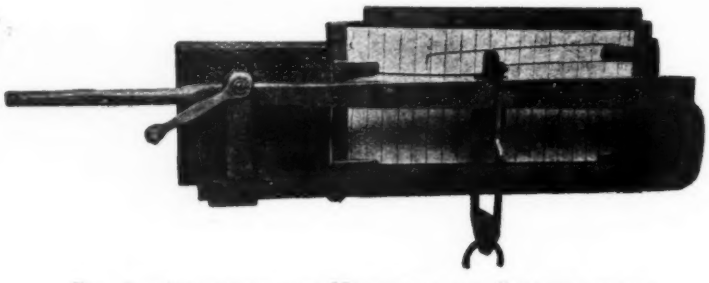


FIG. 9.—ARRANGEMENT OF MECHANISM AND RECORDER OF THE MACHINE SHOWN IN FIG. 8.

M. Portevin's Test.

During the war M. Portevin had the opportunity to test numerous defective semi-steel shells. His opinion on the value of War Office testing methods has been given above as the conclusion of his work. However, he tried to find better and quicker methods to ascertain the value of cast iron. Though his observations were entirely on semi-steel, they can be of service to the foundry, for many of the defective shells he examined were no better than ordinary castings of low phosphorus contents. His methods would have to be investigated in relation to high phosphorus castings before drawing definite conclusions from them.

Portevin, having noticed that ball-tests gave an indication on the value of shells, started experiments to find the relation between ball impression and carefully made tensile and compression tests. These last tests were considered as important, not only because cast iron is often used on compression, but because one of the most important points for shells was that they had to resist an enormous compressive force when the gun was fired. Most of the defective shells tested swelled on the firing test, which was systematically made

* See Memoir on "Le Rivetage Ste. d'Encouragement pour l'Industrie Nationale, 1906."

† This has been confirmed by further experiments of M. Portevin on Semi-Steel. See "Revue de Metallurgie," p. 761, Dec., 1921.

‡ Principles of Iron Founding, Moldenke, p. 163.

on a few shells being taken at random from each lot.

Knowing the importance of oblique pulls on tensile test results, Portevin took special precaution to avoid all chances of error by using the very long and tedious, but only reliable, method of mirrors.

Elastic Limit.

He found that it was very difficult to determine a value for the elastic limit of cast iron. The

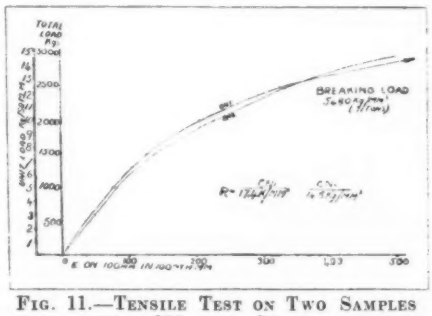


FIG. 11.—TENSILE TEST ON TWO SAMPLES TAKEN FROM 220 MM. SHELLS SWOLLEN AFTER FIRING.

curves obtained by observing the deformations in relation to load, Figs. 10, 11 and 12, do not show any straight portion. The properties of metal can thus only be defined by the entire curve. Figs. 13, 14 and 15 give the curves for other samples. The

Attention is called to the fact that where it has been thought possible to indicate a "limit of proportionality" it is generally less than one-third of breaking strength.

TABLE I.—*Chemical Composition of Samples Used.*

Fig. No.	Chemical analysis.					
	T.C. Ct.	Gr. C. Cg.	Si.	Mn.	P.	S.
	%	%	%	%	%	%
10	3.82	3.25	1.50	0.75	0.13	0.14
12 (curve A) ..	3.65	2.95	1.46	0.77	0.11	0.15
11 (curve B) ..	3.67	2.98	1.48	0.64	0.10	0.16
12 (curve CN2)	3.48	2.86	1.47	0.64	0.06	0.12
13	3.71	3.30	1.30	0.78	0.16	0.19
12 (curve CN1)	3.50	2.87	1.44	0.70	0.06	0.12
14	3.23	2.70	1.13	0.62	0.09	0.19
11 (curve C) ..	2.97	2.35	1.27	0.65	0.07	0.22
15	3.44	2.73	1.24	0.76	0.16	0.14

Modulus of Elasticity.

These curves enable one to determine Young's modulus from the indication on the axle of loads of the straight part of curve when such exists, or the tangent to the origin of the curve in other cases. It can immediately be seen that, contrary to what happens with steels, the modulus varies considerably. It passes from 2,500 to 7,300 tons per sq. in., and it varies, roughly, proportionally to the tensile breaking-load Rt, as can be seen by Fig. 16.

TABLE II.—*Comparative Mechanical Tests on Samples shown in Figs.* 10-18.

Fig. No.	Tensile Test (1)			Compression Test (2)					Transverse Test (4)	
	Breaking load. Rt.	Limit of proportionality. Ept.	Modulus of elasticity. Mt.	Breaking load. Rc.	Apparent elastic limit. Eac.	Reduction of length at breaking. a.	Diametrical swelling. g.	Ball Test (3)	Breaking load. Rf.	Deflection f.
	Tons per sq. in.	Tons per sq. in.	Tons per sq. in.	Tons per sq. in.	Tons per sq. in.	Per cent.			Lbs.	mm.
10	4.4	—	1,841	23.2	13.9	9.0	0.17	105	1,485	—
11 (curve A)	8.5	(1.9)	4,191	39.4	17.1	15.9	0.27	131	1,485	0.28
11 (curve B)	9.3	—	4,000	40.7	19.0	17.5	0.27	143	1,595	0.35
12 (curveCN2)	9.4	—	3,873	41.6	20.3	18.7	0.34	149	1,628	0.32
13	9.9	4.4	4,508	(38.8)	(20.6)	(24.4)	(0.44)	143	—	—
12 (curveCN1)	11.0	—	5,016	42.3	23.4	17.2	0.30	149	1,650	0.38
14	12.7	2.	5,715	49.3	24.7	23.4	0.41	163	—	—
11 (curve C)	13.5	(5.8)	5,905	63.5	31.7	28.1	0.50	187	2,035	0.30
15	16.9	3.0	7,302	63.8	31.7	23.8	0.35	207	—	—

(1) On screwed test pieces 16 mm. dia by 150 to 200 mm. working length.
(2) On cylinders 16 mm. long by 16 mm. dia.
(3) Ball 10 mm. dia; load 3,000 kg.; time 15 secs.
(4) On samples 10 by 10 by 65 mm.; distance between supports 30 mm.; radius of supports and punch 2 mm.

nine samples employed vary between 4 and 17.1 tons per sq. in. tensile strength, and Tables I. and II. outline respectively their chemical and

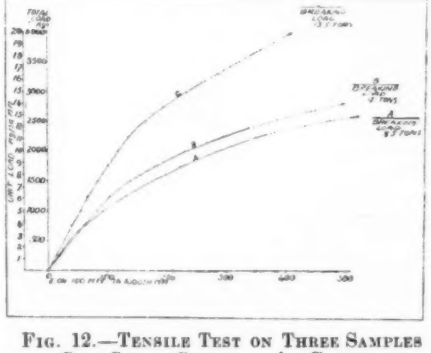


FIG. 12.—TENSILE TEST ON THREE SAMPLES OF SEMI-STEEL SHELLS. *A*, CONTRACTED; *B*, SWELLED; AND *C*, BROKE DOWN ON FIRING.

physical characteristics, it being understood that the "limit of proportionality" used by Portevin instead of elastic limit is only given where a straight part can be more or less seen at the beginning of the curves.

It can be expressed by the empirical formula

$$Mt = 385\ Rt + 1150.$$

The strongest irons have the highest modulus of elasticity. They are less deformable, and consequently more influenced by oblique pulls. That is one more reason in favour of prohibiting ordinary tensile tests for cast-irons.

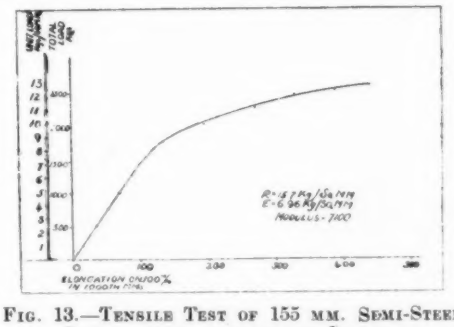


FIG. 13.—TENSILE TEST OF 155 MM. SEMI-STEEL SHELL WHICH SWELLED ON FIRING.

Sounding Tests.

The sounding of projectiles during the war was tried by a special committee as a means of investi-

gation. It was found that—(a) For steel shells it can give a useful indication by observing the length of tone to disclose cracks. (b) For semi-steel shells the height of tone gives an indication of the value of metal. For a same size of projectile, the lower was the tone the worse was the metal. Consequently the sound was retained so as to give an idea of the value of the metal of semi-steel shells, and not of steel shells.

The above conclusions about modulus of elasticity explain why. It is known that the height of sound given by a solid depends on the speed of propagation of sound in it, and that this speed increases as the square root of the modulus of elasticity.

For ordinary carbon steels, the modulus is about the same, and thermal treatments do not change it more than 10 per cent., whilst for semi-steels it varies from 1 to 3. The differences in semi-steel are 100 per cent. each way from the average, and it is very easy to find, by the sound only, what are the best shells of a lot. This remark may be of considerable practical interest.

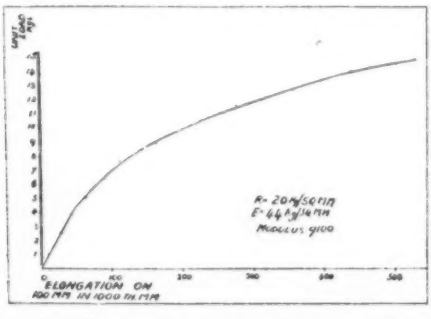


FIG. 14.—TENSILE TEST ON 293 MM. SEMI-STEEL SHELL.

Compression Tests.

As far as possible, cast-iron is used in compression in daily practice. The powder explosion compresses the back of shells, so that the swelling at this time may be very serious; in fact it is the only important deformation to consider for estimating the value of projectile during firing. Thus, it appears important to determine the properties of metal under compression. The compression test only requires simple and short testing pieces, so that this is still a further reason for scrapping the tensile and, in preference, using the compression test.

M. Portevin made experiments on cylinders 16 mm. dia., by 16 mm. high with a recording

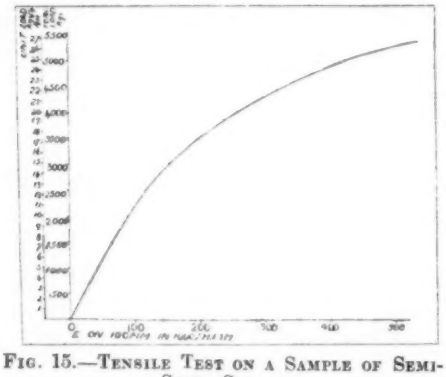


FIG. 15.—TENSILE TEST ON A SAMPLE OF SEMI-STEEL SHELLS.

apparatus. The breaking load and elastic limit were observed. Shortening and swelling were measured afterwards, but on account of the shortness of samples it was not thought advisable to ascertain the modulus of elasticity from the compression. It is one of the advantages of the transverse test, as it gives an evaluation of the coefficient of elasticity.

In the cast-irons examined (see Table II.) the tensile breaking load, Rt, is about 1-4 to 1-5 of compression breaking load, Rc.

The approximate empiric formulæ of comparative results could be written—

$$Rc = 2.5\ Rt + 18.$$

From a much larger number of readings (about 100) it was shown that the apparent ratio of elastic limit to compression can be expressed by following empirical formula for samples 16 mm. high—

$$Eac = 0.2\ Rc - 20.$$

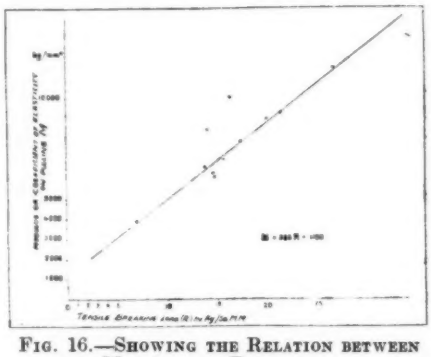


FIG. 16.—SHOWING THE RELATION BETWEEN THE MODULUS OF ELASTICITY AND THE TENSILE STRENGTH.

Elastic Limit and Modulus of Elasticity for Tensile and Compression.—It would be absurd to compare tensile and compression elastic limits of Table II., the experimental conditions not being sufficiently accurate, and also because the definition is too conventional. The size of tensile and compression testing pieces being very different, M. Portevin thought it advisable to make new tests, so as to be able to get accurate data for shell firing.

Similar sized test pieces were selected (Fig. 17) and similar accurate testing methods used. It was necessary to use short pieces on account of the tendency of compressed samples to bend; the length is twice the diameter for tensile, as well as for compression samples. The mirror method was used, the distance between the supports being 50 to 55 mm. The samples were taken as round bars, 60 mm. dia., cast from the same ladle, three of each. The amplification of longitudinal deformation was 700, while the accuracy of machining was

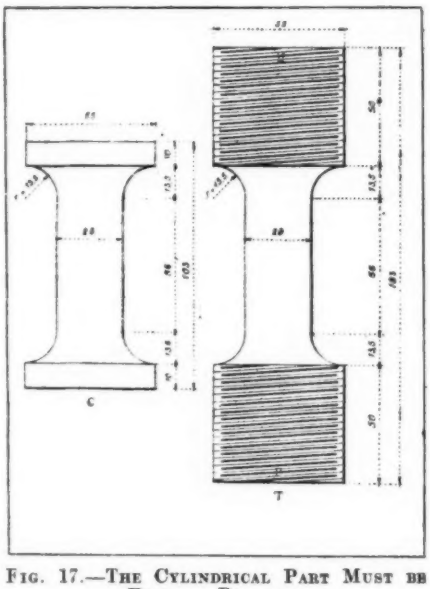


FIG. 17.—THE CYLINDRICAL PART MUST BE EXACTLY PARALLEL.

within 1-100 of a mm.; the variations in length observed on two opposite generatrix noted every 500 kgs., and the test-speed about 1,200 kgs. (2,640 lbs.) per minute. At the beginning the observation of deformations under small loads enabled to interpose lead cushions to reduce oblique pulls to minimum. The accuracy of readings was 1-50,000 of lengths measured.

The material used was of average quality (about Rt = 25 kg.mm.^{2}, or 15 tons per sq. in.).

Results of experiments are shown in Table III. and Figs. 18 and 19.

It can be deduced that the limit of proportionality to tensile, Ept = 3.5 kg.mm.², or 2.2 tons per sq. in.; the limit of proportionality to compression Epc = 12 kg.mm.², or 7.6 tons per sq. in.

From Table III. the following remarks can be made:—

(a) The tensile and compression breaking loads are, roughly, to the ratio given by empirical formula—

$$Rc = 2.5\ Rt + 18.$$

(b) Previous formula would give for the values of Rt and Rc found an apparent elastic limit

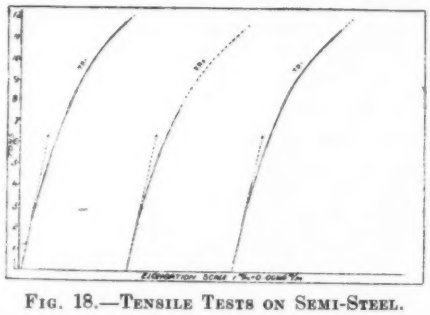


FIG. 18.—TENSILE TESTS ON SEMI-STEEL.

Eac = 50 kg.mm.² (31 tons per sq. in.), whilst the experiments only give 32 kg.mm.² (20.2 tons per sq. in.). The reason is that test-pieces were five times longer, and also that the accuracy was greater. It can be seen by the shape of the curves that this may make a great difference.

(c) The rule, often used, that the compression elastic-limit is three times greater than tensile is entirely wrong; the ratio can vary between 1 and 4 according to the conventional definition adopted and the accuracy of readings on account of the irons. Moreover, the roughness of the tensile test as usually practised renders a comparison valueless.* However, the accurate tests made by M. Portevin are of considerable interest in order to find out whether the ball test gives reliable data on the tensile, etc., strength of cast iron.

From Table II. data has been obtained which shows a remarkable agreement between tensile

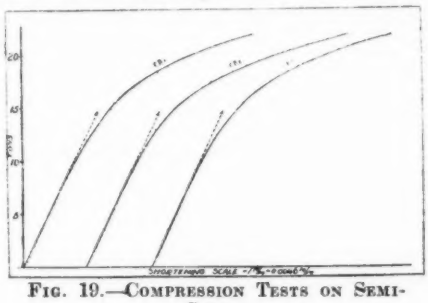


FIG. 19.—COMPRESSION TESTS ON SEMI-STEEL.

strength and ball number. The empirical formula giving the relation is —

$$R\ T = 0.2 \text{ area} - 13.$$

II. *Comparison with Compression Test.*—Here there is a much larger number of readings to work upon, and they show that there is a fair agreement between ball number, compression breaking load and compression elastic limit, determined, as previously mentioned, on cylinders of 16 mm. dia. by 16 mm. length, which can be expressed by empirical formulæ—

$$Rc = 0.5 \text{ area} - 5.$$
$$Ec = 0.4 \text{ area} - 25.$$

Fig. 20 shows graphically the relation between the four values of ball area Rt. Rc. and Ec.

TABLE III.—*Tensile and Compression Tests on Semi-Steel 25 Kg. mm.² Tensile Breaking Load.*

Nature of test.	Marks of test pieces.	Limit of proportionality. (1)	Apparent elastic limit. (2)	Breaking load.	Deformations. In length. At the limit of proportionality. (3)	Deformations. In length. At the breaking load. (4)	Deformations. In section at the breaking load. (5)	Modulus of elasticity.
		Tons per sq. in.	Tons per sq. in.	Tons per sq. in. Per cent.	Per cent.	Per cent.		Tons per sq. in.
Tensile	T.B.1. ..	2.0	13.6	13.6	0.0256	0.384	0.16	8,064
	T.B.2. ..	2.5	16.8	16.8	0.0332	0.597	0.16	7,778
	T.B.3. ..	2.3	16.2	16.2	0.0289	0.540	0.16	8,032
Compression ..	C.B.1. ..	8.25	20.3	57.2	0.115	16.0	34	7,175
	C.B.2. ..	7.2	20.6	56.7	0.105	16.2	31	7,483
	C.B.3.	6.7	19.5	57.6	0.086	16.4	37	7,810

(1) Results (calculated).
(2) Measured on the diagrams by the machine.
(3) „ with mirror apparatus.
(4) „ on 56 mm. of length by determining results with mirror apparatus and direct measurement on samples.
(5) „ on the breaking section for tensile pieces and on the middle of the length for compression pieces.

fact that test pieces for tensile and compression are vastly different in length, consequently no comparison is of any value.

(d) As for steel, the modulus of elasticity to tensile and compression are practically equal, the average value being 12 by 10^3 kg.mm.² (7.6 by 10^3 tons per sq. in.).

There is a large difference between the values found for the limit of proportionality Epc = 12 kg.mm.² and the apparent limit of elasticity Eac = 32 kg.mm.², which, on account of the condition of the test, can be said to be the lower and upper limits of the real elastic limit. So that it can be said that for a cast-iron (semi-steel) breaking at 25 kg.mm.² at the tensile test, the limit of deformation to compression is between 10 and 30 kg.mm.² In fact, under a load of 20 kg.mm.² there is a slight permanent contraction of 0.013 per cent. (the total contraction under the load being then 0.16 per cent.), but to show it the readings must be made with an approximation of 1-50,000 of the length.

Ball Test.

I. *Comparison with Tensile Test.*—The ball test has not yet been used for the qualification of cast

It must be remembered that these ball tests have been made on machined shells, and it may be that some care must be taken to avoid mistakes when the print is made on the skin.

However, this, so simple a test, is most interesting if it is proved that it applies, as it is probable, to common cast iron. Its advantages are that it is very simple, quick, cheap, indestructive, individual, and indelible.

Conclusion.—In conclusion the writer, on behalf of the French Association Technique de Fonderie, calls the attention of parent societies to the importance of the methods here set out for the future advancement of the foundry trade. Up to now the methods used were costly and uncertain. It can be said that, providing an agreement is made between the interested societies to standardise the test-pieces and condition of tests, a considerable amount of data can be obtained in a comparatively short time, if all foundrymen are willing to use such reliable, cheap, and simple methods.

It cannot be questioned that at present, in order

* See Portevin, "Revue de Métallurgie," Dec., 1921, p. 775 F. Wust and K. Kettenbach. F. Wust and R. Meissner Tests.

to determine international specifications for castings, it is too early, but the A.T.F. strongly recommends that a committee is immediately formed between the interested societies to decide if the sizes of testing pieces proposed by MM. Fremont and Portevin cannot be adopted by all foundrymen with a view to render comparable tests made in

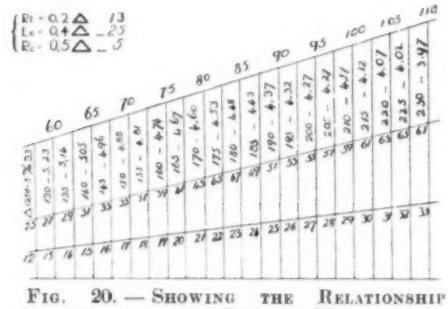
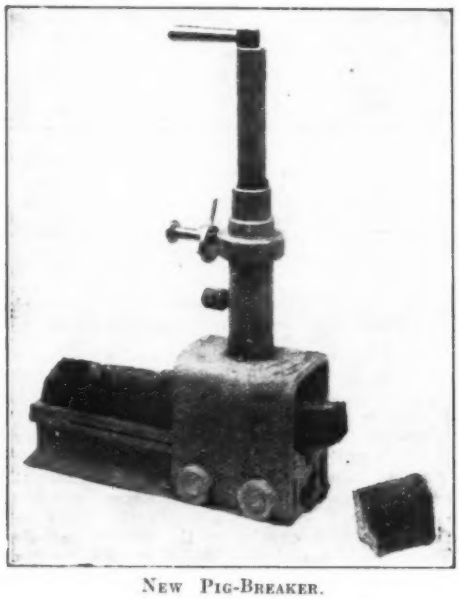


FIG. 20. — SHOWING THE RELATIONSHIP BETWEEN THE BRINELL NUMBER, THE TENSILE STRENGTH (TOP LINE), THE COMPRESSION ELASTIC LIMIT (MIDDLE LINE), AND COMPRESSION BREAKING LOAD (BOTTOM LINE), ALL IN KILOS. PER SQ. MM.

different countries, and, when decided, to investigate the value of the sounding test, and to carry out experiments and collect data from members, with a view to reporting results at a Joint Foundrymen's Meeting.

New Pig-Breaker.

An interesting appliance shown at the recent International Foundry Exhibition at Birmingham, which we mentioned briefly in our description of the exhibits in our last issue, was a pig-breaker, shown for the first time by the Temple Cox Research Company, Limited, of Dacre House, Westminster, S.W., under the auspices of the United Brass Founders and Engineers, Limited, Cornbrook, Manchester. An outstanding feature



NEW PIG-BREAKER.

of this new foundry tool is that its power is derived from a small quantity of a safe variety of sporting powder, its combustion being so controlled that the maximum pressure of the gases is reached before the hammer moves to do its work.

Weighing only 2 cwts. and being independent of the usual sources of power, the pig-breaker is a thoroughly portable machine, and, as will be seen from the illustration, it is very simple in construction. The base is not a fixed design, being capable of alteration to take large sows. It consists simply of a platform raised 4 in. from the ground, on which to slide the pig under the arch, which supports the operating cylinder. This platform terminates a little beyond the cylinder in a slightly raised bridge. Thus, there is a narrow space between the bottom of the pig and the top of the platform where the hammer descends. The hammer is cylindrical in shape, with a ball end, and tapered at the top to fit into the lifting plunger, which by sliding down a slot cut in the side of the narrow portion of the cylinder is made to lift the hammer ready for the next break after it has done its work.

The cases containing the charges are fitted into a hole drilled through the plate of the loading mechanism, and after insertion, the covering plate carrying the detonating pin is moved over into the position shown in the illustration. A pull of the circular handle contracts a spring, which on being released causes the pin to detonate the charge. This pin cannot be operated before the charge is securely covered by the steel covering plate, so that the apparatus is safe in operation. When the charge is detonated the combustion gases separate the lifting plunger and the hammer, the latter being propelled at a very high velocity down on to the pig, giving a blow sufficiently powerful to break the hardest variety in use. The downward movement of the plunger drives the gases remaining in the cylinder against the charge case, and thus ejects it. The whole operation of moving the pig on the platform, inserting the charge, breaking the pig, and raising the hammer ready for the next break takes a few seconds only.

Operating costs are very low, as only the charge and cap are destroyed, the case being used over again. While only one break per charge is claimed, it is interesting to note that in most cases two and even three breaks are caused by the one blow of the hammer. The breaker is 15 in. high, 9¾ in. wide, and its base is 36 in. long.

Personal.

THE late Mr. C. H. Tate, engineer, etc., of Newcastle-on-Tyne, left £5,510.

THE LATE Mr. J. E. Hyde, a director of the Campbell Gas Engine Company, Limited, left £38,939.

THE LATE Mr. E. Dickenson, lately managing director of the Hardy Patent Pick Company, Limited, left £18,191.

MR. C. B. COLLETT, chief mechanical engineer, G.W.R., Swindon, is to have charge of the work of bringing Cardiff Docks' hydraulic equipment up-to-date.

MR. S. SUTCLIFFE, general manager of the Darwen and Mostyn Iron Company, Limited, has been appointed a Justice of the Peace for the County of Flint.

MR. S. J. LLOYD, of the Corby Ironworks, who resides at Brigstock, Northamptonshire, has been re-elected chairman of the Northamptonshire Education Committee.

MR. J. N. PAXMAN, J.P., chairman of Davey, Paxman & Company, Limited, Colchester, who died on March 30, left estate of the gross value of £109,063, with net personalty £105,189.

MR. J. H. GRANT, general manager of the Port Talbot works of the Rio Tinto Company, Limited, and Mr. Ll. David, of D. R. David & Son, Limited, have been appointed on the Commission of the Peace for Port Talbot.

MR. ARTHUR BALFOUR, managing director of Arthur Balfour & Company, Limited, and deputy-chairman of the Associated British Chambers of Commerce, was entertained at luncheon recently at the Hôtel Cecil by the American Chamber of Commerce in London.

MR. C. F. JONES, secretary of the Dalmuir establishment of Wm. Beardmore & Company, Limited, has just retired after a long and honourable career in the firm's service, totalling 45 years. Mr. Jones has been the recipient of a handsome presentation, subscribed to by over 200 members of the staff, at Dalmuir and other works, as a mark of their esteem.

THE general audit of the South Wales and Monmouthshire Iron and Steel Workers for the three months ended May 31, 1922, shows an increase in wages to the workmen who come under the sliding-scale of 4 per cent. as and from July 1, 1922. The sliding-scale at the present time is 51½ per cent., so that it would be 55½ per cent. above the standard for the quarter commencing on July 1.

The Preparation of Moulding Sand.*

By Heintx Kalpers.

A considerable amount of time elapsed before the fact that the quality of the moulding sand was recognised as the chief feature for the production of a perfect casting with a smooth and dense surface free from blow-holes found general recognition. The main point at issue is to obtain the requisite essential properties of good moulding sand, viz. : plasticity suited to the purpose in question and adequate permeability for the gases produced, in the desired relative proportions. It is also generally known that apart from the above properties good moulding sand should also possess a certain refractoriness as well as general strength. These conditions can only be complied with by employing suitable machines and appliances, immaterial whether the latter work independently and be charged separately or whether they be brought into interdependence by means of conveyor worms, bucket elevators, shaking troughs or similar means, thereby representing such a complete unit as to render the preparation of the sand entirely automatic from the first charging point up to the final discharging of the finished sand.

The actual preparation of the sand comprises the preparation and mixing of the new sand, of the old

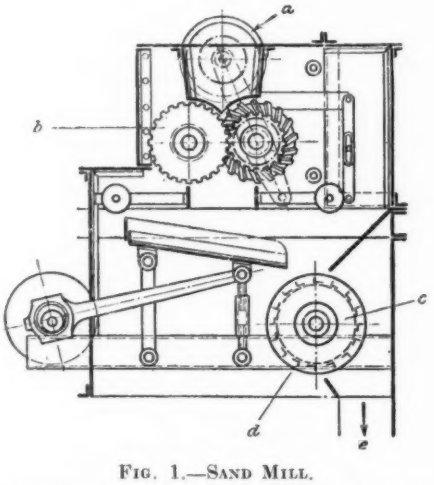


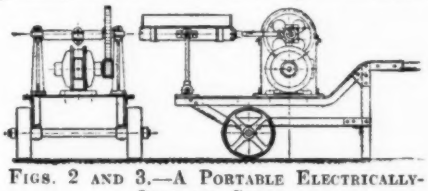
FIG. 1.—SAND MILL.

(a) Charging Hole. (b) Crushing Rollers. (c) Magnetic Roller. (d) Discharge for iron. (e) Discharge for sand.

sand, and of the coal dust. The ratio of combining these three components depends primarily on the purpose for which the sand is to be employed and is determined by the question as to whether grey cast-iron, malleable iron, cast steel, or non-ferrous metals (alloys like brass, bronze, yellow, red or white metal, etc.) are concerned. Moreover, it is necessary to consider the size of the castings so that big foundries with a variety of products are forced to employ a number of sands of varying compositions.

Preparation of New Sand.

The preparation of new sand principally consists in drying, disintegrating and sifting. The drying of the sand mainly aims at extracting the moisture contained in the sand in order to prevent the formation of clots which would be troublesome in the disintegrating process and in the sifting. Formerly this drying process used to be performed in drying chambers. Latterly, however, this method has been given up and drying is effected by means of horizontal revolving drying drums or in vertical drying furnaces working on the counter-flow principle, the latter chiefly striving for as economical a utilisation of fuel as possible. The furnace put on the market by a German firm is characterised by its peculiar arrangement and fastening of the drying trays, inasmuch as a rigid tray and a movable one are provided alternately, whilst the coming adrift of one of the movable trays of its own accord is at the same time effectually precluded. The sand is conveyed to the top and into the furnace by means of a bucket elevator and drops in to the uppermost tray. On the latter it is scraped towards the inside, whereupon it drops on to the next one which conveys it forward again and so on in constant repetition and continually against the current of heat until it finally reaches the bottom of the furnace in a dry condition. On leaving the furnace, it drops into a trough. The output of such furnaces depends upon their size and varies between 1 and 3 tons per hr., the power consumption for driving the shaft fluctuating between 2 and 5 h.p. Owing to the possibility of controlling the number of r.p.m. of the shaft as desired it is possible to control with accuracy the time in which the sand is to pass through the furnace and, consequently, the time of drying which must obviously be made to correspond to the moisture contained in the sand. When dry the sand must be disintegrated to have a perfectly uniform grain, the size of which is essentially indicative both as regards its future permeability for gas and the plasticity of the finished material. A coarse grain reduces the plasticity, but on the other hand the grain of the sand must also not be too fine because in this case the spaces intervening between the particles of sand would become too small so that the permeability for gas would suffer in consequence. The disintegrating process in question is generally carried out in ball mills or in pug mills. Ball mills should preferably be used where very fine sands are desired. Pug mills, on the other hand, may be asserted to



FIGS. 2 AND 3.—A PORTABLE ELECTRICALLY-OPERATED SIEVE.

have found the most wide-spread application. After passing through the pug mill the green sand is finally preferably taken through a rotating polygonal sieve in order to separate off coarser particles of sand that may still be contained in it. Clots of sand retained by the sieve are put through the pug mill once more.

Preparation of Used Sand.

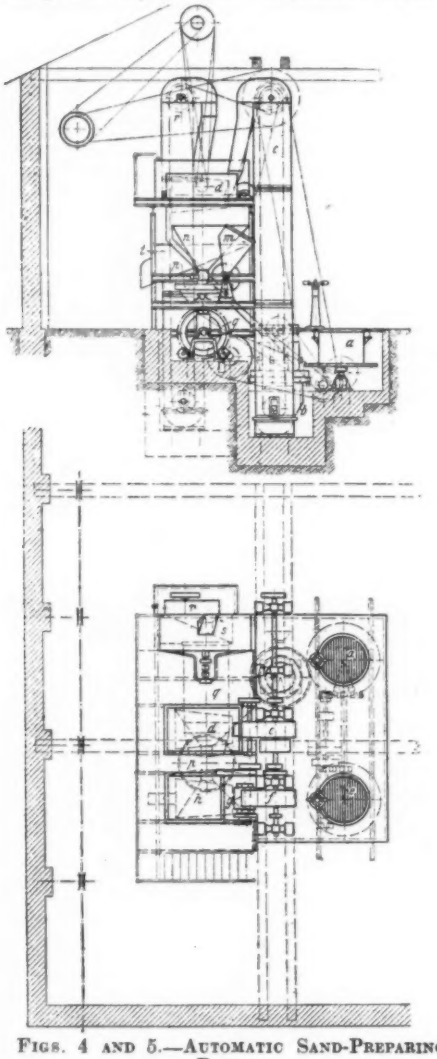
The preparation of used sand usually consists in disintegration by further sifting. At the same time, however, it is necessary to provide precautions for extracting particles of metal or iron that may be contained in the sand. The sand mill shown in Fig. 1 has proved suitable for treating used sand. With this machine the sand is fed in at the top and passes between two rollers, one of which is arranged to swing backwards and forwards in such a way as to allow particles of iron contained in the sand to drop through. After being crushed between the rollers, the sand drops on to a charging chute below the rollers which delivers the material to an electro-magnetic roller serving to extract the particles of iron from the sand.

The used sand then passes on to another polygonal sieve or shaker in the same way as the new sand, the sifting machines possessing either gear drive or direct drive by electric motor or pneumatic drive. The sifting machines are manufactured in all kinds and sizes. A sieve of practical construction is illustrated in Figs. 2 and 3. It is a portable shaker with electric drive and can easily be run to any part of the foundry where it is simply connected up with the existing electric main by means of an ordinary plug connection. Such a sieve is capable of delivering three to four cub. yds. per hr. at a power consumption of only approx. ¼ h.p. The motor is fully enclosed in a dust-proof casing and completely protected against all possibility of dust or dirt penetrating to its interior. It is a specially notable feature of this machine that any ordinary round foundry sieve may be employed,

* Abstracted from "Engineering Progress"

such a sieve simply being inserted in the wrought-iron annular support where it is fixed in position by a spring-loaded bolt or catch.

For the purpose of mixing and loosening up the fresh and the used sand as uniformly and thoroughly as possible, it is now customary to use mixing machines, all the more modern designs of which show vertical construction. Among these machines various types must be distinguished inasmuch as there are modifications with rotating pin cages, some with fixed pin cages and others with two pin cages rotating in opposite directions. The ratios of mixing the various ingredients of the moulding sand depend upon the practical experi-



FIGS. 4 AND 5.—AUTOMATIC SAND-PREPARING PLANT.

(a) Charging apparatus for new Sand. (b) Disintegrator or Crusher for new Sand. (c) Bucket Elevator for new Sand. (d) Sifting Machine for new Sand. (e) Charging Apparatus for old Sand. (f) Bucket Elevator for old Sand. (g) Crushing Mill for old Sand. (h) Sifting Machine for old Sand. (m) Coal-dust Bunker and Distributor. (n) Hopper for prepared new Sand. (o) Hopper for prepared floor Sand. (p) Distributing apparatus with rotating horizontal disc. (q) Preliminary Mixer and Wetting Apparatus. (r) Bucket Elevator for semi-finished Sand. (s) Aerator (t) Final Discharge Hopper.

ences of each individual foundry and are incidentally also determined to a very large extent by the size of the casting to be produced.

Preparing the Coal Dust.

Ball mills are the most suitable machines for preparing the coal dust required in grey iron foundries, as these mills supply the finest and most uniform material. It is generally known that coal dust must be added to the moulding sand in order to prevent the casting from burning fast to the mould during the casting process by producing gases in the course of its combustion which cause the formation of a thin stratum of gas between the moulding sand and the molten iron which precludes the formation of a fusible slag.

As mentioned above, entirely automatic drying plants have latterly also been introduced for the complete drying of the moulding sand, such plants representing a combination of a number of separate machines in such a way as to make the whole plant take up very little room and, in most cases, require the attendance of only one man, whilst at the same time it offers maximum capacity. The arrangement of the various component units is based upon the principle of making the sand travel in one direction only while eliminating long distances.

Automatic Plant.

An automatic sand plant of the kind indicated above is illustrated in Figs. 4 and 5. Briefly the working of the plant and production of the finished moulding sand is as follows: The dry fresh sand first reaches a pug mill *via* a charging apparatus and is then ground to a perfectly uniform consistency. After this it is taken by a bucket elevator which conveys it to a drum sieve, whence the sand drops into a storage bunker. The used sand is delivered to a charging contrivance in a similar manner and then conveyed upwards with the aid of another bucket elevator. It is then cleaned electro-magnetically of the iron adulterations contained in it, whereupon it is disintegrated or ground in a sand crushing mill. After dropping through another drum sieve and after having been freed from all further impurities exceeding a size of 10 mm. it is finally deposited in a storage bunker. Below the two bunkers a distributing contrivance permitting of accurate control is provided and a coal dust charging apparatus is installed on top of the latter. The three materials, *e.g.* fresh sand, used sand, and coal dust undergo a preliminary mixing process, the desired proportions of each of the three being added to form the mixture, whilst the mixing process itself takes place under addition of water. Thereupon the material, which by now has been thoroughly cleaned, disintegrated, moistened, and mixed preliminary, is conveyed upwards to the mixing machine by means of a bucket elevator. The mixing machine serves to loosen up the material and to render it permeable to gas. Thus having been dressed completely, the moulding sand finally drops into a storage bunker whence it can be fetched in any desired quantities and entirely ready for use.

The capacity of such plants which incidentally can be adapted for use with all manners of different sands, varies between 2, 3, 5 and more cub. yds. per hr. according to size. As a matter of fact plants with capacities up to 30 cub. yds. per hr. have even been constructed. It is thus evident that in foundry engineering technical thought and iniative have, in the course of developments, devised ways and means of increasing and improving the productive capacity, whilst simultaneously creating working conditions that are satisfactory from an economical point of view both as regards the finished product as well as human labour and the question of economy of space.

MILD STEEL CASTINGS, LIMITED, have given a lease of their foundry and plant to Birmingham Electric Castings, Limited, and the former company have ceased manufacturing, the lessees undertaking the completion of all orders in hand. All correspondence in future for Mild Steel Castings, Limited, should be addressed to their London office, 91-93, Bishopsgate, E.C.2.

The Commercial Secretary to His Majesty's Legation in Copenhagen (Mr. Richard Turner, O.B.E.), has reported to the Department of Overseas Trade that the Danish State Railways are inviting tenders for the supply of some 31 tons of points and crossings, material and accessories. Tenders have to be submitted by July 12. The documents in connection with this contract can be obtained only from the Danish State Railways in Copenhagen against a deposit of 50 kroners, but a set (in Danish), including drawings, can be inspected by United Kingdom firms interested on application at the Department of Overseas Trade (Room 50A), 35, Old Queen Street, Westminster, S.W.1. No translation is available in the Department. The Department can supply the name of a suitable representative in Copenhagen to act in this matter for United Kingdom firms interested who are not represented there by their own agent. (Ref. 5807/FR/EP.)

Moulding a Trunk Casting in Loam.

By A. L. Ross.

The object of this article is to describe a simple method of moulding a trunk or cross-head guide casting which is used for modern winding engines. A general outline of the casting is shown by Figs. 1, 2, and 3.

Instead of making a whole pattern and core-box, which would be a rather expensive item, the only patterns required are as follows:—(1) Two striking boards, one to strike the outside diameter of the casting, including the flanges, the other to strike the core, or inside diameter of casting. (2) One pattern for bracket A, Figs. 1, 2, and 3, shown by Fig. 7. The inside of this bracket is made by means of a core held in position by means of one or two wrought-iron spikes. (3) Two patterns for ribs B, Figs. 1, 2, and 3, shown at Fig. 4. (4) One corebox and strickle for the openings C, Figs. 1, 2, and 3, shown by Figs. 5 and 6. (5) A template to fit in flanges to give the correct position of the bosses D, Figs. 1, 2, and 3, shown by Figs. 8 and 9.

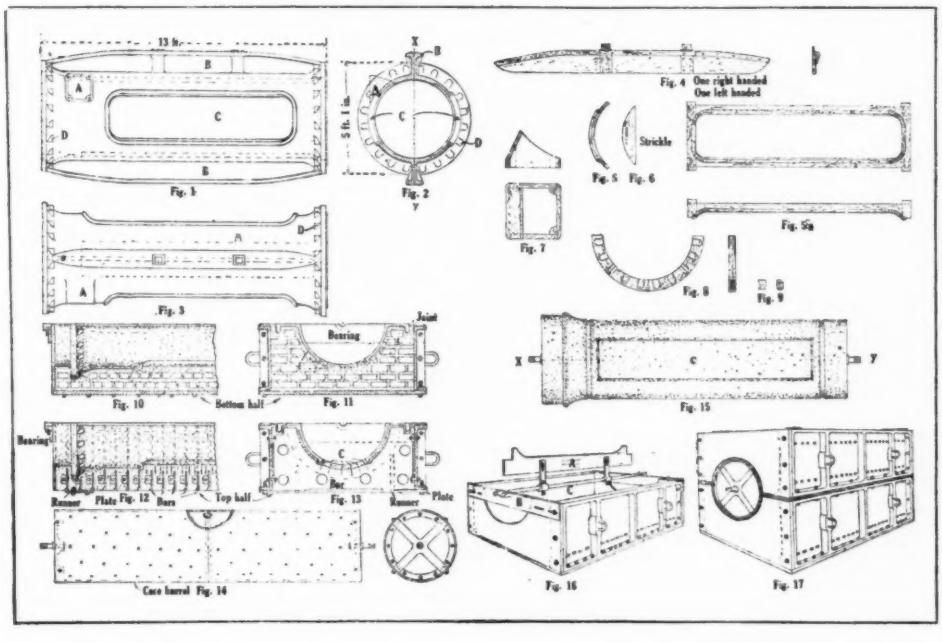
Before commencing to mould, the following tackle must be made:—Two box parts, top and bottom, shown in Fig. 17; these boxes are usually useful for other similar castings. One spindle of 3 in. dia. and two bearings, which are shown in Fig. 16 at C and B; the bearings are placed on the edges and the bosses are bored to suit the spindle. On the spindle two collars are fastened, one at each end, to prevent endwise movement. These collars are not shown in the drawings. To the spindle is attached the striking board A, Fig. 16, by means of the two cast-iron arms D, Fig. 16.

The bottom part having been securely bolted together, it is set as level as possible on the foundry floor. Next, the bearings, B, Fig. 16, are fixed dead-level and central with the box sides, and about 1 in. above the box edges, as shown in Fig. 16. The spindle is placed in the bearings, the arms, D, Fig. 16, having been put on the spindle previously; the collars are now fastened on the ends of the spindle, and the striking board attached to the arms, D, Fig. 16.

The bracket, Fig. 7, is now set in position. The next operation is to brick up to the joint, taking care to leave room for the rib patterns, set out in Figs. 10 and 11; these are set level with the edges of the bearings by means of a long straight-edge. The patterns are then rammed round with core-sand, and the other parts of the mould roughened up with loam, leaving it to stiffen for a while. The mould is struck up with fine loam, and the joint strickled off. The spindle and bearings are then removed, taking care to replace the bolts, which held the bearings in place, into the box again. One or two fires are placed in the mould to harden the loam, and, when hard enough, the core-box, Fig. 5, is bedded in position. After ramming up the core-box with core-sand, strickle off by means of the strickle shown in Fig. 6. The core-box and the other patterns can now be withdrawn, and the template, Fig. 8, placed into one of the flanges. The bosses, Fig. 9, of which three or four are required, are bedded into the spaces cut out of the template. The same operation is carried out with the other flange, and the bottom part is then ready for the stove. Fig. 10 shows a longitudinal section of the bottom part, showing half the mould only. Fig. 11 shows a cross-section of mould and the box.

The top part next demands attention, and its construction is clearly shown in Figs. 12, 13, and 17. The bars are about $\frac{7}{8}$ in. thick, and are bolted to the sides by means of lugs. Over the flanges, two plates are fastened, one of which has two holes for the runners and the other one hole for a riser.

The bottom part can now be proceeded with, but before placing the spindle in position, ram the whole of the box up with floor-sand to within about 1 in. from the bar edges, except those bars in which the flanges are. These are rammed with core-sand. The bar edges are clay-washed and the whole is rammed with core-sand; the spindle is placed in its bearings and strickled off; the rib pattern is bedded in, the whole of the mould damped and struck up with fine loam. The mould can then be proceeded with as for the bottom part.



Both parts of the mould are taken from the stove and the top part turned over on two logs by means of the staples. It is then lifted on to the bottom part, and any discrepancies in fit are rectified, the joints loam-marked, and the top lifted off again. The top and bottom parts are now ready for finishing.

The centre core needs very little explanation. Fig. 14 shows the core-barrel, which is made in two pieces and bolted together in the middle. About $2\frac{1}{2}$ in. are left for loam around the barrel. The barrel is struck up to a diameter equal to the inside of the facings, C, Fig. 15. The core being dried, the facings, C, Fig. 15, are set as follows:—Mark two centre lines on the core diametrically opposite each other, one of which is seen at X Y, Fig. 15. Nail four pieces of lath to the core in their proper positions and strike up the core for the last time. Allow loam to set and remove laths.

All that remains now is to stove and finish off. Fig. 16 shows a perspective view of the bottom part ready for bricking. Fig. 17 gives a perspective view of the mould closed and bolted together ready for casting, the runner and riser basins not being shown.

The above is a most effective and easy way of moulding anything of a cylindrical form which will allow of being cast in a horizontal position.

Foundry Ladles.

By M. K.

In times of abnormal output and of keen-cut prices one finds the greatest evolution in machine tool practice. To an observer of foundry machinery numerous instances at once appeal. One might cite the development of moulding machines during the period of activity of the late war, and the interest that is now developing in cupola practice.

Yet in perhaps one or two sections foundry practice has, for a number of years, remained at a standstill. To the users, principally, of foundry ladles this article is intended, since most British manufacturers are still sufficiently conservative to decline to market an article unless there exists a demand.

The conditions generally under which ladles work are well known, but one might briefly enumerate the salient points that have to be contended with. They are:—(1) Dirt. (2) Heat. (3) Lack of skilled attention.

Small Ladles.

Of the smaller types of hand ladles little need be said, except that it is desirable that these be made of the weldless type, *i.e.*, both the bowls and mountings weldless. Owing to the rapid introduction of steel, the class of blacksmith who would weld up iron mountings with five or more welds is becoming scarce, and one is led to the conclusion that sooner or later hammer welding at a smith's hearth will become extinct. For this reason it is desirable that welded mountings should be avoided. Where bands are fitted round the ladle these should be of triangular or cope section, to avoid splashing when filling. The bowls should be easily detachable from their mountings, so that the lining may be dried out in a core oven.

Bogey Ladles.

Of bogey ladles one can only say that the wheels should be of large diameter and narrow tread, and should run on either ball or roller bearings. This ensures that the ladle can be pulled easily and steadily, with the entire absence of the tugging and splashing that usually marks the progress of large ladles whose bogey wheels are small and lubricated by grease and foundry sand. Whichever form of bearing is adopted, it should be so enclosed as to be dust- and dirt-proof. Some means of lubricating under pressures, such as by means of Stauffer lubricators, is desirable, so that any dirt that may work in will be forced out again. Where the wheels are fitted on the trunnions of the ladle it is desirable that they be machined in place to ensure alignment.

Large Ladles.

In large ladles the trunnion bearings are subjected to considerable temperatures, which may reach 200 deg. C., if the ladle is allowed to remain filled or partially filled for any length of time. This rise in temperature must be allowed for in designing the working parts of ladles.

The length of the arms seems to be a controversial point amongst foundries, but a purely mechanical view favours the long arm, as keeping the bridge shackle and crane hook away from the heat of the metal in the ladle. As the temperature of the bridge and shackle will probably vary as the square of the length of the arm, and as the strength of steel falls rapidly as the temperature rises, the arms should be as long as working conditions permit.

Regarding the bowls themselves, for the smaller sizes the pressed shell type is undoubtedly the best. The built-up bowls are heavier, but are usually used for ladles, say, over 20 cwt. capacity, owing to the difficulties of pressing the larger sizes satisfactorily. The lips in the larger sizes should be detachable, and so designed as to give a stream of metal approximately rectangular in width and depth. Some simple form of skimming device should be fitted behind the lip of the ladle, so as to retain slag. For ease in lining, the rivets should be countersunk in the inside, especially in the case of steel ladles which are bricked.

Geared Ladles.

In the case of geared ladles, the gearing should be either totally enclosed or totally open. If only semi-protected, then in the event of anything getting into the gears and jamming, the casing will delay its removal. The totally open type is cheaper, but wears rapidly. The enclosed type is the better practice.

The gearing should be machine cut, and it is probably no more expensive to the manufacturer to do this. The reduction should be so arranged as to give a travel of 4½ in. to 6 in. of the lip per revolution of the turning handle. When cold, there should be some shake or backlash, so that the gears may work easily when hot. If this backlash is excessive, the ladle will splash at the points at which the turning movement reverses.

The volume of the gear casing, in the totally enclosed type, being large, there is no necessity for any provision for lubrication of the gearing other than filling up the box with grease periodically, say, every twelve to fifteen months.

Steel Ladles.

Steel ladles should also have an internal angle round the top, to retain the brick lining. In fact, some ironfounders call for an internal angle round the top edge. There is no necessity for bands except for purely ornamental purposes, as the body of the ladle should be amply strong to take the bursting pressure without additional stiffening. It is better to rivet the trunnions through doubling plates, to distribute the stress more evenly over the bowl.

Simplicity in design is, above all, essential, both as a feature of economy in manufacture and to ensure reliability in operation.

Classes in Foundry Work at Leicester.

An evening class in foundry work was started at the Technical School in Leicester last session. It was the first of its kind held in Leicester, though the need for such a class had been felt for some time. A total of 45 students enrolled, two being foundrymen, thirteen foundry apprentices, twenty-four pattern makers and apprentices, and six engineers, etc. The instructor was Mr. P. A. Russell, B.Sc., works metallurgist at a local foundry.

The syllabus, being largely experimental, was arranged to include as wide a range as possible, and included pig-iron production, cupola practice, elementary metallurgy of cast iron, steel and non-ferrous metals, foundry practice in detail, and pattern design. Owing to the nature of the class it was necessary to start from the most elementary point of view on all subjects, but the interest of every type of student was well sustained, and there was an average attendance of 34.5 for the lecture course. An examination held at the close of the session showed that satisfactory progress had been made by most of the students.

In addition, a practical class was held for those who had not come into actual contact with foundry practice. The accommodation and time allowed were very restricted, but each of these students was able to make at least one simple mould for himself.

One interesting feature of the class was the large attendance of pattern makers, who seemed to be very glad to take this opportunity of learning more of the methods by which a casting was made from a pattern. Comparatively, the attendance of foundry apprentices was poor, and several large foundries in the city were not represented at all.

The experience gained from this class has encouraged the Education Authorities to expand the course into two classes next session, which will enable them to meet more adequately the different needs of each type of student.

The support which this class received is yet further evidence of the general desire that is now felt for more foundry education.

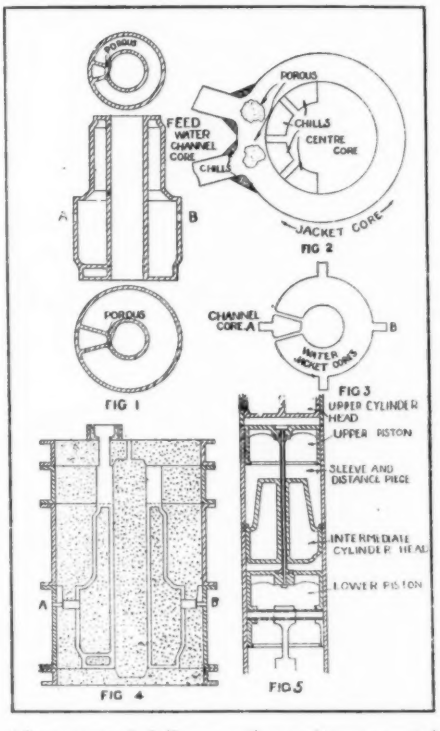
Intermediate Cylinder-Heads for Vertical Gas-Engines.

By S. G. Smith.

The following is an experience the writer had with a particular design of cylinder-head for vertical gas-engines. This casting had an exceptionally bad record for a long time: at one period seven castings were made before a good one was obtained.

The cylinder-heads in question were comparatively small, being only about a quarter of the size and weight of the larger heads, which with ordinary care no trouble was experienced. It is partly due to the smallness and thickness that the problem of making sound pressure-proof castings were involved. There is an important difference between the small heads now considered and the large heads. It is a vital difference, as will be seen later.

From Fig. 1 it will be seen that the head is cast in one piece. With the larger cylinder-heads the bore, or central part of the head, is cast separately in the form of a liner, and fitted into the head, which is a much simpler and a more sure method of producing a casting free from porosity.



After several failures, the writer approached the engineers as to the practicability of making the bore of this and similar heads separate in the form of a liner, on the same lines as the larger heads, but the suggested change was not entertained, consequently the only course open was to persevere until some method could be found to produce a casting that would meet their requirements.

Long before the writer's attention was directed to these failures, various ways and methods had been tried to overcome the trouble, but without success. As in the case of many other engine parts, the fault was not discovered until the hydraulic test was applied. It was repeatedly found that the failure was in the same locality, indicated in Figs. 1 and 2, and took the form of porosity at the junctions of the water-channel walls and the bore walls of metal.

It is interesting to note that this head forms part of a line of pistons, and is situate between them in the vertical position, as shown in the drawings. The head is fixed midway in the cylinders, thus forming a division; hence the term, intermediate cylinder-head. The top cylinder-head, which is of quite different design, is fixed in the top of the cylinder with the upper piston underneath.

A cast-iron sleeve, which also acts as a distance-piece between the two pistons, is fitted with four rings and passes upwards and downwards with the stroke; hence the bore of the cylinder-head must have a perfectly sound and dense surface. This will be appreciated by reference to Fig. 5. The temperature of the cylinder-head, under load, rises considerably; especially is this so at the firing, or combustion end of the head (which is the bottom end, as is shown in the diagrams), consequently the head must be cooled by a flow of water continually passing through. It is due to this that it is necessary to subject the casting to a hydraulic test.

It is usual, when testing this type of cylinder-head, for the water-inlet to enter from the outside of the large diameter of the casting into the walled internal channel which diverts the water to the hottest part of the head, also it distributes the water throughout the head to the outlet, which, of course, is blocked for pressure purposes; thus the head is tested all over, including the bore. It is at this juncture that the water finds the porous places in the situation already indicated, as both ends of the bore are left open for the purpose of inspection under pressure test. It is the narrow channel that diverts the water in the jacket which is the root cause of the trouble, and is brought about in the following manner:—

A jacketted casting, when the area of the jacket core is small, and in combination with a thick bore, it is not always easy to obtain the necessary density in the bore, but when in addition two walls of iron forming a narrow channel down the length of the head, which forms two continuous junctions of iron lengthwise into the bore, such conditions contribute to maintain the metal in that locality in the molten state, not only to be drawn from, but must of necessity be the last places to solidify; hence, from the very slow cooling, some segregation must occur, if only from the precipitation and growth of carbon flakes due to extremely slow solidification, and retarded cooling afterwards.

From an ordinary drawing of small scale these junctions do not look abnormal, but when it is marked out in full size, with the corners off and the angles put on, as shown by a small area of the channel with junctions into the bore in Fig. 2, it indicates the real difficulties to be overcome.

As stated, various ways of pouring, gating, and feeding had been tried, additionally the quality and temperature of the metal was altered. Fig. 2 has purposely been included to show to what length chills were applied, both in the jacket cores and centre core. The application of chills did not sufficiently hasten solidification at the junctions to prevent the porous formation. In other words, uniform cooling was not taking place to the extent of eliminating the open and segregated areas.

As will be seen from Fig. 2, fillet-shaped chills were applied near the junctions in both the channel and jacket-cores; these chills were applied in the form of long strips and laid in the jacket-core boxes. Had it been convenient to make these chills heavier, it would have been done, but when dressing the casting it is remembered that the whole of the sand, cinders, irons and chills of which the core was composed had to pass through three or four 1½ in. dia. holes, it will be seen that the size of the chills was limited. With the centre core the chills were applied in segments, as shown in Fig. 2; these were ¾ in., placed about ¼ in. apart, and extended half the length of the core. Although the size of the segment chills would exert a densening effect upon the iron, it was not sufficient; when bored out, the denser iron would be removed.

The castings, to which the chills were applied, were slightly improved, but that is all that could be said. Owing to the failure of the chills in both jacket and centre core, other methods must be found to remove the porosity. The writer has on

several previous occasions, when densensers have failed, resorted to an unusual form of feeding. This course was pursued in the present case. The form and dimensions of feeder are shown in Fig. 4.

A point had now been reached when half-measures were not entertained; something had to be done to prevent all possibility of the defect occurring. This was accomplished as follows:—All chills were eliminated; a feeding head, 12 in. long, the same diameter as the small end of the pattern, was added. On top of the feeding head was a 3-in. dia. feeding riser, to be fed by rod; the centre core was continued through the feeding head, as shown in Fig. 4, which outlines one view of the assembled mould. Since the adoption of this method with this type of cylinder-head there has not occurred a single instance of a waster due to porosity in any part of the casting.

Fig. 3 shows a cross section of the jacket core, through A B of both Figs. 1 and 4. The whole weight of the jacket cores rests upon the 1½ in. dia. cores, through which also the expanded air and generated gases escape during pouring. With the exception of the three or four small holes the jacket cores are enclosed in metal.

Of course, there was the usual grumble from the machine shop about having to cut off the head, but this attitude gradually became less pronounced when it was seen later that the castings were satisfactory.

It may reasonably be asked: In what way does this feeding head eliminate all porosity from the casting? This may be answered by stating that the feeding head remains longer in the molten condition than any part of the casting, thereby compensating any part or parts of the casting that have been drawn from (liquid contraction) during the solidifying period; also the static pressure of the heavy feeder would increase the density in all parts of the casting. This has been proved many times over upon examination when the feeding head has been taken off.

The mixture of iron at all times used for these castings must give a dense and close-grained fracture. The analysis of such a mixture of iron poured into a 1½ in. sq. test-bar (not attached to the casting) should approximate to the following:—C.C 0.80, Gr.C 2.30, P 0.50, Mn 0.80, Si 1.00, and S 0.12 per cent. The tensile break of the bar from the above would be about 12 tons per sq. in. and the transverse breaking load, on 12 in. centres, would be about 3,000 lbs. per sq. in.

The above analysis and physical tests, with a dense fracture, can be obtained by the use of expensive brands of iron, but the same results may be obtained from the use of inexpensive brands of iron.

In the former case cold-blast and special blends of iron are included, and in the latter a judicious use of white iron, or steel scrap mixed with selected grades of ordinary pig-iron. In conclusion, it should be noted that the dimensions and weight of such feeding heads allows for and covers possible margins of error in quality, density, pouring rate, and temperature of the iron.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Semi-Steel.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Mr. Cameron is to be congratulated on his paper on semi-steel as much for the negative as the positive results which he gives. No doubt so-called semi-steel, or otherwise a mixture of steel, pig-iron and scrap gives a close grained material, and if melted under proper conditions the iron will give all the beneficial results claimed, but what adds to the value of Mr. Cameron's paper are the difficulties connected with the use of semi-steel enumerated on page 497 of the paper, for it is true to say that to ensure the best results it has to be handled on a fairly large scale, and when only a small quantity is required in, say, a jobbing foundry, the results are never so good, for in fact the steel does not get properly melted. It is chiefly because of these difficulties in small foundries that I have consistently advocated getting close grained castings from originally close grained metal.

On page 496 Mr. Cameron states that No. 1 pig-iron was generally used as machinability was most desirable. No. 1 is, of course, a high total carbon and high graphite metal, but on page 21 it is stated that low carbon contents in pig-iron used for semi-steel is essential. In my opinion Mr. Cameron is right if it is intended to use a large percentage of steel scrap, one of the chief reasons being that the low combined carbon with the No. 1 iron will make it difficult to melt, and consequently greater superheat will be required in melting, thus bringing the temperature required nearer to that which would be necessary to properly melt the steel used.

In spite of care in using steel, difficulties still sometimes arise, and in one case I met with two large hard places on the flange of the exhaust end of a turbine casing, giving the impression that punchings had been used as steel scrap, and two of them had not become thoroughly liquid, but, in their plastic condition, had got into the ladle and from the ladle lodged in their natural position on the flange at the *top* part of the casting, which unfortunately had to be machined at this spot. The metal was made from a mixture of 25 per cent. steel, with pig-iron and scrap run first into pigs.

It is delightful to hear men of practical experience making definite statements, that at one time were not believed. On page 497 an instance is given of 18 tons tensile with over 3 per cent. silicon, and further on it is stated that semi-steel does not owe its qualities to chemical analyses so much as to physical structure, that analyses are excellent in themselves, but must be considered in connection with physical structure. With these statements I have for many years been in entire agreement.

It is further interesting to note on page 498 that Mr. Cameron recommends soft blast and a tuyere area of 1 to 4. Fifteen years ago I increased my tuyere ratio to 1 to 3½, and with a 10-oz. pressure attained excellent results.—Yours, etc.,

E. ADAMSON.

Book Review.

COMPANY MANAGEMENT. By H. C. Emery. Published by Effingham Wilson, 16, Copthall Avenue, London, E.C.2. Price 12s. net. This book is written for directors, proprietors of businesses, secretaries, cashiers, and clerks, as it deals with the vital steps taken by any firm. Whilst it is not for the purpose of helping the general or shop manager to organise production, it contains information which any ambitious manager should know.

There are in British foundries many ambitious men who have ideas that they should start in business for themselves, but whilst they are quite capable of running an established concern, they have no knowledge as to how a company should be formed. Invariably they have to rely upon their solicitor. The object of this book is to enlighten, in simple language, the whole procedure of company formation and management, from the matter of choosing its name right up to (if, unfortunately, necessary) its "winding up." All such matters as Articles of Association, Prospectus, Shares, Directors' duties, Books to be Kept, Mortgages, Banking, are fully dealt with. It is a type of information which seldom filters through to the technical staff, but at the same time, whilst it is not essential, it is very useful knowledge for them to have, in preparation for the time when such matters have to be tackled.

MR. W. SMITH, chairman and managing director of Thomas Smith & Sons of Saltley, Limited, Saltley Mills, died recently. A well-known Birmingham manufacturer, Mr. Smith was born on July 11, 1843, in Birmingham. He was apprenticed to Messrs. Mackenzie & Company, Sand Street, and when he had completed his time there he joined his father, the late Mr. Thomas Smith, and established the present business at Saltley Mills.

National Physical Laboratory Report, 1921.

The Executive Committee of the National Physical Laboratory, in the course of their Report for 1921, remark that work in the Laboratory on iron and steel has been devoted mainly to the further investigation of the constitution of the iron-nickel-carbon alloys, the iron-phosphorus alloys, and to the determination of the temperature of melting in the iron-carbon system. For this latter purpose an electrical method, first developed in connection with the study of the constitution of the aluminium-copper-nickel-system, is being successfully applied. Full particulars of this work are given in the Report of the Department of Metallurgy made by the Superintendent to the Director, and forming part of the present N.P.L. Report.

A considerable amount of investigatory test work has been carried out in relation to cases of failure in iron and steel, particularly the cracking of boiler plates around rivet holes. The preparation, in conjunction with the Iron and Steel Institute, of chemically standardised steel samples, of accurately determined chemical composition, has further progressed, and a number of standards are now ready for issue.

In the statement of work proposed for the year 1922, it is mentioned that the research work of a fundamental character referred to in the Report for 1920 will be continued during the current year, subject to modifications arising from developments of the work itself and from changes of programme adopted by various Committees and Organisations in connection with which the work is carried out. As regards light alloys, the programme of research approved by the Materials Sub-Committee of the Aeronautical Research Committee, and recently approved by the Engineering Research Board of the Department of Scientific and Industrial Research, will be further carried out.

A certain amount of further work is also required, and will be carried out, in connection with the Alloys Research Committee of the Institution of Mechanical Engineers. This work arises out of and constitutes in some respects the completion of work described in the Eleventh Report to the Alloys Research Committee recently published.

The main work to be undertaken under the auspices of the Alloys Research Committee of the Institution of Mechanical Engineers will relate to the study of ferrous alloys, primarily binary alloys of iron with other elements in the absence of carbon. This work will include in the first place the determination of the constitutional diagrams of some of the more interesting systems of this kind, and where possible the correlation of the diagrams obtained with the physical properties of the materials. This work is later to form the basis of a systematic study of various important groups of ternary alloys of iron with other metals, carbon, etc.

It is proposed to continue the investigation of the phenomena of cracking in iron and steel and other metals, and also to investigate the phenomena which occur when mild steel under stress is exposed at various temperatures and pressures to the action of caustic soda solutions of different strengths. Apparatus for this purpose is being designed and will be constructed and put into use. In this connection, investigations will be made of any cases coming under the notice of the Department, of cracking in boiler plates.

The study of the iron-nickel-carbon system will be continued as well as the determination of the solidus curves of the iron-carbon system. The further extension of work of this kind will now come under the programme of the Alloys Research Committee. On the other hand, the investigation of special systems will be taken up as and when required for the elucidation of cases of failure arising in practice.

The issue of the standardised samples will be continued, and the preparation of further standards will be undertaken in conjunction with the Iron and Steel Institute. Work on the investigation of cast iron from the point of view of standardisation will also be undertaken. A programme of cast-iron research will be arranged with the Cast Iron Research Association.

Research will be continued upon the physical structure of metals and alloys, particular attention being given to the measurement of the heat generated by plastic deformation. The experiments already made on the behaviour of the more plastic metals in tension will be continued and efforts made to obtain a higher degree of accuracy in the determination of the heat evolved. Incidental to the above researches, the further investigation of the properties of amorphous metal is required.

In the Report of the Engineering Department for 1921 it is stated that the method of predicting fatigue ranges of stress which has hitherto been employed at the Laboratory, has been by means of a series of tests on different specimens (usually six) at different ranges of stress, commencing with a range well above the fatigue limit so that fracture occurs after a comparatively short number of reversals, and then progressively diminishing the range of stress for the other specimens until fracture fails to occur with a number of reversals of the order of five to ten millions. It is then comparatively easy by means of plotting to predict the limiting range of stress. This method, although otherwise satisfactory, is slow and costly, and several attempts have been made by workers in this field to predict the fatigue range of stress from a test on a single specimen of the material. One method is that due to Dr. J. H. Smith, who has found that by attaching an optical extensometer to a specimen under reversals of tensile stress, the stress-strain curve obtained, under gradually increasing range of stress, exhibits a "yield-point" characteristic similar to that found in static tests, and that the range of stress corresponding to this yield point is the true fatigue range of the material.

A calorimetric method has been devised by Mr. Stromeyer for use in alternating torsion tests. In this method the specimen under test is water-jacketed and the temperature of the circulating water carefully observed. The torsional fatigue limit is determined by noting the stress at which a small but perceptible rise of temperature of the jacket water due to the heating of the specimen by internal work takes place. In the N.P.L. experiments carried out during the year, both of these methods were used simultaneously on the same specimen under alternating tension, the chief modification being that instead of using a water jacket the temperature of the specimen was determined by a thermo-junction. Satisfactory agreement between the two methods and the results of fatigue tests on the material by the ordinary Wöhler method have been obtained for the case of a wide range of materials.

The method of "yield ranges" has also been extended to tests on specimens subject to reversals of bending stress in the ordinary Wöhler fatigue testing machine. A plane mirror is mounted on the end of the specimen with its plane perpendicular to the axis of rotation. The changes in the slope of the plane of the mirror, due to gradual increases of the load on the specimen, are observed by means of a source of light and a long optical lever (40 yards in length). On plotting the results on a base of stress range a "yield point" can be detected at a stress range which is identified with the fatigue range of the material. By means of these methods the time necessary to predict the limiting range of stress has now been reduced to less than half an hour.

As regards indentation hardness tests, a special depth indicator for measuring the depth of the indentation from the original surface has been obtained from Messrs. Alfred J. Amsler, of Schaffhausen. An attachment has been made by means of which this may be fitted to the Laboratory axial loading compressor shackle, and a series of tests has been carried out. The results will be communicated to the Hardness Tests Research Committee.

As is well known, the Brinell hardness test is unsuitable for steel whose hardness number exceeds 500, on account of the permanent deformation of the ball which takes place in such cases. Some consideration has been given to the possibility of determining a scale of hardnesses for very hard materials from the amount of permanent flattening of the ball, and an instrument has been constructed in the workshops by means of which this flattening can be measured. A series of tests has been made on some specimens hardened by Messrs. Hadfields, and the results are of considerable interest. Given careful manipulation of the instrument and a trained observer, and provided that a supply of steel balls of uniform hardness can be obtained, it is believed that the method will be a valuable one in discriminating between the hardness numbers of very hard steels.

The Annual Inspection by the General Board took place on June 27. The usual display of testing apparatus and results of tests was given. Amongst items of interest was a steel column cased with concrete which had failed in the testing machine under a stress of 55 tons. A similar steel column, not so cased, failed under a stress of 4 tons. Fatigue tests were in progress on a Stromeyer fatigue-testing machine. Investigations into the behaviour of light aluminium alloys under heat treatment show that by suitable heat treatment it is possible to give an increase of as much as 50 per cent. in tensile strength to light alloy castings. In connection with aluminium zinc alloys, a peculiar effect was demonstrated in the spontaneous generation of heat after quenching. The alloy was cooled sufficiently to allow of its being handled, but suddenly there was a rise of temperature, which made it impossible to hold the metal in the hand. This was due to molecular changes, which come on a few minutes after the quenching.

Trade Talk.

WILLIAM ATKINS & COMPANY, LIMITED, and Kitson & Company, Limited, have joined the Federation of British Industries.

A DESTRUCTIVE fire occurred at the Pembroke Dockyard on Saturday last, and the moulding shop was completely destroyed.

KENNEDY & DONKIN, civil engineers, of 17, Victoria Street, have removed to Broadway Court, 8, Broadway, Westminster, London, S.W.1.

COOPER & KING, LIMITED, electrical and mechanical engineers, have removed from 37, Westgate Street, Cardiff, to 17, Castle Street, Cardiff.

THE ENGLISH ELECTRIC COMPANY, LIMITED, have an order from the Imperial Government Railways of Japan for thirty-four complete electric locomotives.

THE imports of foreign ore at the Senhouse Dock at Maryport last week amounted to 2,500 tons. At Workington dock the imports of ore last week were 1,250 tons.

RECENT ship-repairing contracts placed on the Clyde include the re-engining of the Canadian Pacific liner "Victorian" at Fairfield, and the overhauling at Clydebank of the same company's "Empress of Australia."

THE STEEL CONSTRUCTION COMPANY, LIMITED, of Glasgow, are supplying the steelwork of the first section of a new boiler-house at the Ferryhill electricity works of the Aberdeen Corporation. The contract price is £8,113.

THE works of Wm. Whitwell & Company, Limited, have been taken over from Amalgamated Industrials by Head, Wrightson & Company, Limited, and it is expected that the two furnaces there on hematite will soon be restarted.

BY an arrangement between Sir W. G. Armstrong, Whitworth & Company, Limited, and the Works Committee at Elswick Works, the firm has agreed to advance 10s. on account to men who started work between June 14 and June 20, the money to be repaid at the first full pay on July 7.

SIR W. G. ARMSTRONG, WHITWORTH & COMPANY, LIMITED, are to build two caissons for the new graving dock at Durban, which is being constructed by the Union Government. The same firm have contracted to overhaul and repair the swing bridge at Newcastle, which was built by them forty-seven years ago.

E. G. APPLEBY & COMPANY, LIMITED, of 70, Victoria Street, S.W.1, have recently sold fourteen of the Bentley patent adjustable, balanced and floating agitators, combined with mechanical rotary fuel feeds, for fitting on to their Kerpely gas producers, with automatic ash discharge. Several of these sales are repeat orders.

POTT, CASSELS, AND WILLIAMSON, of Motherwell, have an order from the Tvomal Sugar Factory, Pekalongan, Java, for seventy-five electrically-driven units, the baskets being of steel, 36 in. diameter, and 18 in. in depth. Each machine will be driven by a separate three-phase A.C. motor, 1,200 r.p.m., through a special form of friction clutch.

THE TEES-SIDE BRIDGE AND ENGINEERING COMPANY, LIMITED, Middlesbrough, which recently secured an order for 125 steel wagons for the Indian Railways, have this week secured from the Admiralty a contract for 15 oil storage tanks, each 116 ft. in diameter, with a capacity of 3,000,000 gallons. These tanks are for Singapore, where the firm is at present erecting six similar tanks.

ALFRED HERBERT, LIMITED, Coventry, have been appointed selling agents in South America for Vulcan Foundry, Limited; Clayton Wagons, Limited; British Griffin Chilled Iron & Steel Company, Limited; Watson, Saville & Company, Limited; C. B. Parry, Limited; and Howell & Company, Limited. Alfred Herbert, Limited, will manage the agencies through their branch at 25, de Mayo, No. 267, Buenos Aires.

THE TATA IRON & STEEL COMPANY will shortly offer for subscription about £2,000,000 of 7 per cent. debentures. This week the offer of ordinary and preference shares of Platt Brothers, textile machinery manufacturers, is expected. The £1 ordinary shares are to be offered at 43s., and the £1 7 per cent. cumulative preference shares at par. The valuation of the assets is nearly £6,500,000, of which goodwill figures for about £1,500,000. The profits for the past five years were at the average rate of £611,000 per annum.

AT the 82nd annual conference of the Amalgamated Wire Drawers' Society of Great Britain at Southport, the general secretary stated that the executive had determined that all members who had exhausted unemployment benefit be considered still entitled to benefit. During last year £33,596 was paid in unemployment benefit, a sum unprecedented in the annals of the trade. Four thousand pounds had been paid to retired members in superannuation. Mr. Ellison was re-elected vice-president, and Mr. Birtles general secretary for a further five years.

Cupola Melting Tests with Mixtures Changing During Run.*

BY DR. RICHARD MOLDENKE, Watchung, N. J.

This paper describes a series of tests of melting varying composition charges in cupolas. Usually the foundryman considers that by placing an extra charge of coke between different composition mixtures in the cupola, the irons can be kept separate for pouring. The results of the tests described show that iron is melting in several charges at one time, iron high up in the cupola melting near the lining. The Bethlehem Steel Co. conducted an investigation of this question by using a pig-iron containing 1.20 per cent. nickel and 2.40 per cent. chromium. Four cupola charges, each separated by a double charge of coke, were melted, the data obtained being as follows:

Charge No.	In Mixture % Ni.	% Cr.
1	0.00	0.00
2	0.12	0.24
3	0.18	0.36
4	0.24	0.48
Charge No.	**In Castings Ni. Range**	**Cr. Range**
1	0.08 to 0.12	0.16 to 0.24
2	0.09 to 0.13	0.23 to 0.37
3	0.08 to 0.11	0.23 to 0.30
4	0.08 to 0.12	0.23 to 0.38

The results indicated that it is very difficult to separate iron mixture in the cupola. The paper also discusses precautions to be used in charging the cupola.

Company News.

Gibbons Bros. (Dudley), Limited.—Interim dividend, 3½ per cent.

Kayser, Ellison & Company, Limited.—Usual half-yearly preference dividend passed.

Pather Iron & Steel Company, Limited.—Dividend, 5 per cent.; carried forward, £8,337.

Millom & Askam Hematite Iron Company, Limited.—Interim dividend on ordinary shares passed.

Wallace (Glasgow), Limited.—Loss, £10,365, which with balance brought forward makes total debit £179,759.

Broughton Copper Company, Limited.—Further ordinary dividend, 10 per cent. actual, less tax, making 12½ per cent. for year.

Irvine's Shipbuilding & Dry Docks Company, Limited.—Half-yearly dividend on 8 per cent. cumulative preference, less tax.

Prince of Wales Dry Dock Company (Swansea), Limited.—Profit, £10,746; available, £12,299; final dividend, 7½ per cent., less tax.

V. P. & G. Hastings, Limited.—Capital £5,000 in £1 shares. Engineers. Registered office: Duchy Chambers, Clarence Street, Manchester.

W. Blackburn (Kew), Limited.—Capital £1,000 in £1 shares (800 8 per cent. cumulative preference). Engineers. Director: W. Blackburn.

Wallaby's, Limited.—Capital £1,000. General and mechanical engineers, etc. Directors: H. N. Wallens and S. A. Piper. Registered office: 69, Summer Row, Birmingham.

W. H. Sugden & Company, Limited.—Capital £2,500 in £1 shares. Engineers. Directors: W. H. Sugden and Mrs. D. E. Sugden. Registered office: Glenny Road, Barking.

J. J. Hardy & Sons, Limited.—Capital £10,000 in £1 shares. Brass founders. Directors: R. N. Allanby and H. B. Olsen. Registered office: 1, Clifton Street, Hartlepool, Durham.

Richard Johnson, Clapham & Morris, Limited.—Net profit, £185; brought forward, £31,848; available, £32,033; ordinary dividend for half-year, 2½ per cent., less tax; carry forward, £23,520.

Johnson, Savage & Company, Limited.—Capital £500. Electricians, mechanical engineers, etc. Directors: R. M. Johnson and E. M. Savage (secretary). Registered office: 1, Argyle Street, Oxford Circus, W.

Edgar Allen & Company, Limited.—Net profit, £25,238; brought in, £30,246; total, £55,484; final ordinary dividend, 6d. per share, free of tax, making 1s. per share for year; carried forward, £20,068.

W. Markes & Company, Limited.—Capital £6,000 in £1 shares, to acquire the business of general brass founders, etc., carried on as W. Markes & Company. Registered office: 32, Waterloo Street, Birmingham.

* Abstract of a Paper presented before the Rochester Meeting American Foundrymen's Association.

IRON AND STEEL MARKETS.

Pig-iron.

Movements in the pig-iron markets so far have not yet realised anticipations that a settlement of recent labour disputes would be promptly followed by an early revival of active buying on home account, the trade generally remaining in a lethargic condition as concerns consumers' demands. The outlook, however, may be regarded as more hopeful, additional furnaces in most districts having been already relighted, while others are reported to be in preparation for a resumption of production as required in the future. The present output is considered quite sufficient for existing needs as regards foundry iron in the Midlands, where some stocks have accumulated during the lock out, of which a substantial reduction must be made before blowing in some of the idle furnaces. Both Derbyshire and Northamptonshire qualities maintain firm quotations, No. 3 foundry grades being held at 82s. 6d. and 77s. 6d. to 80s., with forge irons at 75s. and 70s. to 72s. 6d. respectively. In the Glasgow market, the impending summer holidays are having a curtailing effect upon the already limited buying, while demands on home account continue quiet. Some inquiries from America are, however, reported, for which the prices offered are not considered satisfactory, and so far the business completed has been disappointing. Foreign competition is also becoming active, Continental foundry iron having been offered to Falkirk consumers at 93s. delivered, as compared with 98s. 6d. for Cleveland No. 3, whilst Northamptonshire qualities are offered at a shade lower than foreign imports. On Tees-side little improvement in buying has been experienced, but export business shows slightly more activity, fair shipments going to Germany, and further inquiries on American account being under consideration. The prevailing inactivity in the foundry industry may be regarded as the chief factor in the present diminished demand for Cleveland iron, for which prices remain stationary as follow : No. 1 and silicious, 95s. ; No.3 G.M.B., 90s. ; No. 4 foundry, 87s. 6d. ; No. 4 forge, 85s. ; mottled and white, 80s.

Although the hematite position in North Lancashire and South Cumberland is somewhat better the present output is quite sufficient to meet all requirements, and at some furnaces stocks of iron are held. There are fuller inquiries on general home account, and with the end of the summer trade is expected to be materially improved. Prices remain steady with parcels of mixed nos. of Bessemer iron at £5 15s. per ton, delivered Sheffield.

Finished Iron.

Conditions in the finished iron branches disclose little improvement in the position, which remains irregular and discouraging, most of the works continuing either only partially employed, or completely idle, forges and foundries especially passing through a very trying time. Fresh specifications for crown bars are the subject of keen market competition, in which the disparity of prices offered, and occasionally accepted, is difficult to explain. For example, some makers of these brands of material continue to hold out for the full minimum quotation of £11 15s. for best quality crown, but generally the maximum may be estimated at £11, while even 5s. under that figure is reported obtainable from certain firms in the district. Commoner qualities of bars for nut and bolt producers is making nominally £10, and Black Country makers are fairly well employed, but Belgian competition is again becoming active, material from this source being reported obtainable at £1 below local quotations. Buying, however, is still confined to hand-to-mouth requirements, and in the circumstances imported material, even with a small price reduction, cannot be regarded as a serious factor from a competitive point of view. It is not improbable also that the approaching quarterly meeting at Birmingham may have a retarding influence on placing new business, intending purchasers withholding orders in the expectation of obtaining more favourable terms, an anticipation hardly likely to be realised judging from the present high costs of production and transport.

Steel.

Although at the moment only a limited volume of business is passing in steel and its various products, there can be no question that a certain amount of optimism is current in the trade, not so much perhaps as regards the immediate possibilities, but in respect of future expansion consequent upon more settled industrial conditions. In Sheffield there are already signs of returning activity, numerous steel furnaces having been restarted, while others are in course of preparation. Some fairly substantial orders have been placed recently for railway material for permanent way and vehicular requirements, while the automobile industry is buying on a freer scale, and tool steel makers are also better provided with work than has been the case for some time past. In the market for semi-products, acid and basic billets are in renewed demand, foreign competitions in these lines having practically disappeared for the time being, owing to exchange and financial difficulties, thus affording opportunities for recapturing overseas trade formerly controlled by American and Continental interests. Scottish steel sheet makers also report gradually improving conditions, the Colonies taking fair-sized shipments, while other markets abroad are circulating inquiries that should eventually materialise in substantial orders. On the North-East Coast there is evidence of returning confidence in steel trade circles, indications of the improved outlook being that even orders for plates and other shipbuilding material are coming to hand, which points to a revival of interest in new tonnage. Makers generally, however, are still inclined to wait for lower prices. There has been no change in quotations recently, but the concession of export rates to home buyers where steel is required for constructional contracts abroad will, no doubt, prove extremely valuable.

Scrap.

Business in scrap metal in most markets is again reported quiet and uneventful, although signs of improvement may be noted in some sections due in a measure to probabilities in connection with a revival of foundry demands, and partly perhaps to a depletion of stocks by the recent heavy exports to the Continent. In the Cleveland market there is no demand for heavy cast-iron machinery scrap, which is nominal at 79s. to 80s. per ton, with ordinary descriptions 75s. In regard to heavy wrought iron, there is no demand for piling or propelling, each of which is nominal at 60s. Specially selected heavy forge can be sold in small quantities at 75s per ton. Turnings and borings are very scarce, and such quantities as are available realise 45s. per ton. All these prices are delivered works.

Tinplates.

For the present tinplate makers being fairly well provided with orders in hand do not seem favourably disposed to discuss forward business, and although transactions on any scale of magnitude are few, a number of small specifications have been placed, making a substantial aggregate. The basis paid rules about 19s. 9d. for July, and 19s. 6d. for August-September. The standard sizes coke finish are quoted at follows :— I C 14 x 20, 112 sheets, 108 lbs., 19s. 6d. to 19s. 9d. per box ; I C 28 x 20, 112 sheets, 216 lbs., 39s. 3d. to 40s. per box, with about 2s. 9d. basis extra for cross, and lights at usual reductions. Terneplates.—This market is still rather quiet, but prices keep steady at round 18s. basis and upwards for usual specifications, net, f.o.b. Makers are well booked up for the next 4 to 6 weeks.

Metals.

Copper.—During the past week there has been moderate activity in the standard copper market, with values on the whole having an easier tendency. Business on home consumption account has been on an unimportant scale, while Continental demand also is limited in volume. Reports from the States indicate a less independent attitude on the part of sellers induced probably by disturbed labour conditions, the threatened railway strike having an adverse influence on metal markets generally. Refined descriptions maintain their firmness, electrolytic being firm at £70, and wire bars £71. Current quotations, *Cash* ; Wednesday, £61 5s. ; Thursday, £61 12s. 6d. ; Friday, £61 17s. 6d. ; Monday, £62 10s. ; Tuesday, £62 10s. *Three Months* : Wednesday, £61 15s. ; Thursday, £62 2s 6d. : Friday, £62 7s. 6d. ; Monday, £63 ; Tuesday, £62 17s. 6d.

Tin.—A somewhat remarkable feature in the week's market has been the consistent steadiness of values evidenced by standard tin, in spite of a generally disappointing inquiry from the consuming industries in this country and elsewhere. The tinplate trade of South Wales has recently been fairly active, but no great demand seems to have been in evidence in that direction for the metal. In other markets inquiry has also been poor, the Continent buying little or nothing, while America's spasmodic purchases are small in volume. It would appear, however, that tin at the current level is considered worth buying, as, in spite of steady sales by the East, all the metal which comes out is very well absorbed. Current quotations : *Cash* :

Wednesday, £152 7s. 6d.; Thursday, £151 17s. 6d.; Friday, £152 12s. 6d.; Monday, £154 2s. 6d.; Tuesday. £153 17s. 6d. *Three Months*: Wednesday, £153 7s. 6d.; Thursday, £153; Friday, £153 12s. 6d.; Monday, £155 2s. 6d.; Tuesday, £154 15s.

Spelter.—Messrs. Rudolf Wolff & Company report that business with consumers has fallen off somewhat, galvanisers' requirements being on a very moderate scale. On the Continent the market is quiet and fairly steady, while reports from the U.S.A. are firm. Current quotations:—*Ordinary*: Wednesday, £27 12s. 6d.; Thursday, £27 17s. 6d.; Friday, £28 5s.; Monday, £28 5s.; Tuesday, £28.

Lead.—Supplies of soft foreign pig are still restricted, although a fair amount of business is passing, chiefly for early deliveries. With an active consumption in America, and consequent prices above the London parity, we are chiefly dependent upon Spain for requirements, Australia at the moment being practically out of the market. English lead is steady. Current quotations:—*English*: Wednesday, £26; Thursday, £26 5s.; Friday, £26 5s; Monday, £26 15s.; Tuesday, £26 15s.

Gazette.

A WINDING-UP ORDER has been made against Metal Smelters, Limited, Amberley House, Norfolk Street, London, W.C.

THE UNITED ENGINEERING COMPANY, LIMITED, 22, Basinghall Street, London, E.C., are paying a first and final dividend of 9s. 3d. in the £.

THE PARK TOOL & ENGINEERING COMPANY, LIMITED, are being wound up voluntarily, with Mr. J. Woodthorp Stead, 18, East Parade, Leeds, as liquidator.

THE UNITED SHIPBUILDERS & REPAIRERS, LIMITED, are being wound up voluntarily, with Mr. J. A. Campbell, 17, South Street, Finsbury, London, E.C., as liquidator.

MESSRS. J. H. BARRACLOUGH and E. E. CLARKE, electrical engineers and contractors, Alhambra Buildings, Morecambe, trading under the style of Ernest E. Clarke & Company, have dissolved partnership.

THE PARTNERSHIP heretofore existing between Messrs. J. J. T. Hargrave and A. H. Shalless, at 192, Bedford Road, Rock Ferry, Chester, as electric and mechanical engineers, under the style of Hargrave & Shalless, has been dissolved.

Deaths.

MR. D. A. MILLAR, manager of John James Smithies, Limited, iron, steel and nail merchants, of Rochdale, died on June 15 as the result of a motor accident. The deceased gentleman was in his forty-fifth year.

MR. J. T. MIDDLETON, of Everlands, Woking, has died at the age of 75. The deceased had been connected with the firm of Sir Walter Scott & Company, Limited, contractors and Portland cement manufacturers, of Newcastle, for more than 50 years. Joining the company as a youth, Mr. Middleton served his time as a contracting engineer under Mr. (afterwards Sir) Walter Scott. Subsequently he became a partner with the late Sir Walter Scott and the late Sir John Scott. The name of the firm was then changed to Walter Scott & Middleton. On the death of Sir Walter Scott, about 12 years ago, he became chairman and managing director of the business of Walter Scott & Middleton, Limited. Later, on the death of Sir William Stephenson, he became chairman of the firm of Walter Scott, Limited. He was also connected with the Mountain Copper Company, Limited; Manning, Wardle & Company, Limited; and Smith, Patterson & Company, Limited.

Geology of the An-Shan Iron-Mine District, South Manchuria.—A very carefully prepared report, with the above title, by Mr. Hanzo Murakami, a Japanese geologist, has been published by the South Manchuria Railway Company. The An-Shan iron-ore deposits are, of course, the source of supply on which the An-Shan Steelworks are based, and the deposits were only discovered in 1909, as the result of a survey conducted by the South Manchuria Railway. Indeed, the Russians when laying the railway from Harbin to Port Arthur had no inkling of the iron belt, in spite of the fact that the railway track crosses the middle of it. During the war the two blast furnaces were started, and were completed in May, 1919. They have a capacity of 250 tons a day each. The ore is mainly hematite-quartz-schist, of sedimentary origin, running, as a rule, from 35 to 45 per cent. iron. The ores of the district have many points of similarity to the iron formation of the Lake Superior district of the United States. The report is well illustrated, with 26 plates, and is an important contribution to our geological knowledge of the occurrence of iron ores.

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Manufacturers of

FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

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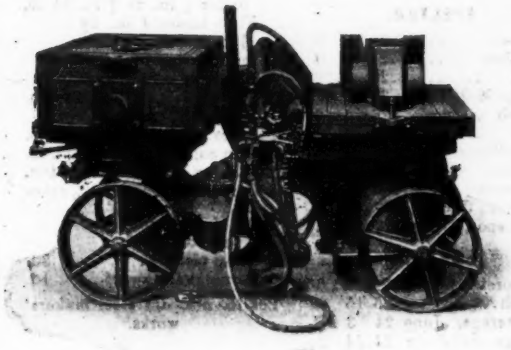

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Works: TOTTENHAM, LONDON, N.17.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	62	10	0
Three months	62	17	6
Electrolytic	70	0	0
Tough	66	10	0
Best selected	66	10	0
Sheets	94	0	0
India	83	10	0
Wire bars	71	0	0
Do. July	71	0	0
Do. Aug.	71	0	0
Ingot bars	70	10	0
H.C. wire rods	75	0	0
Off. aver. cash, June	62	0	11¼
Do. 3 mths., June	62	8	5¼
Do. Settlement June	62	1	0½
Do. Electro, June	70	1	2½
Do. B.S., June	67	12	2½
Aver. spot price, copper, June	61	19	11¼
Do. Electro, June	70	15	8½
Solid drawn tubes			13½d.
Brazed tubes			13½d.
Wire			10½d.
Yellow metal rods			6½d.
Do. 4x4 Squares			8½d.
Do. 4x3 Sheets			9½d.

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13d.
Rods, drawn	10½d.
Rods, extruded or rolled	6½d.
Sheets to 10 w.g.	9½d.
Wire	9½d.
Rolled metal	9½d.

TIN.

	£	s.	d.
Standard cash	153	17	6
Three Months	154	15	0
English	154	10	0
Bars	156	0	0
Chinese	153	0	0
Straits	157	0	0
Australian	156	10	0
Eastern	157	0	0
Banca	154	5	0
Off. aver. cash, June	152	12	3½
Do. 3 mths., June	153	14	5½
Do. Settlment June	152	12	3½
Aver. spot, June	152	11	1

SPELTER.

	£	s.	d.
Ordinary	28	0	0
Remelted	25	15	0
Hard	20	0	0
Electro 99.9	32	5	0
English	28	5	0
India	22	5	0
Prime Western	28	5	0
Zinc dust	40	0	0
Zinc ashes	4	15	0
Off. aver., June	27	16	1¾
Aver., spot, June	27	17	11¼

LEAD.

	£	s.	d.
Soft foreign ppt	24	2	6
English	25	15	0
Off. average, June	24	3	2¾
Average spot, June	24	14	2

ZINC SHEETS.

	£	s.	d.
Zinc sheets, English	36	0	0
Do. V.M. ex. whf.	36	0	0
Do. ppt., f.o.b., N.Y.			—
Dutch	36	0	0
Boiler plates	34	0	0
Battery plates	34	10	0

ANTIMONY.

	£	s.	d.
English regulus	25	15	0
Special brands	32	10	0
Chinese	24	0	0
Crude	14	10	0

QUICKSILVER.

Quicksilver 11 10 0 to 12 10 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
45/50%	13	2	6
75%	23	5	0
Ferro-vanadium—			
35/40%	18/6 lb. va.		
Ferro-molybdenum—			
70/75%	6/- lb. mo.		
Ferro-titanium—			
23/25%, carbonless	1/2 lb.		
Ferro-phosphorus, 20/23%	£20		
Ferro-tungsten—			
80/85%, carbon free	1/5 lb.		
Tungsten metal powder—			
98/99%	1/8 lb.		
Ferro-chrome—			
4/6% car.	£25		
6/8% car.	£24 10		
8/10% car.	£24		
Ferro-chrome—			
Max. 2% car.	£69		
Max. 1% car.	£80		
Max. 0.70% car.	£95		
67/70%, carbonless	1/9½ lb.		
Nickel—99%, cubes or pellets	£162 10		
Cobalt metal—98/99%	10/6 lb.		
Aluminium—98/99%	£100		
Metallic Chromium—			
96/98%	5/- lb		
Ferro-manganese (net)—			
76/80%, loose	£15		
76/80%, packed	£16		
76/80%, export	£14 10		
Metallic manganese—			
94/96%, carbonless	2/4 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. to 8 in. inclusive	4d. lb.
Rounds and squares under ½ in. to ¼ in.	3d. lb.
Flats under 1 in. by ⅛ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness	3d. lb.
Bevels of approved sizes and sections	6d. lb.
If in coils	3d. lb.
Packing	£3 ton.
Bars cut to length	10% extra

Scrap from high-speed tool steel—

Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy Steel	3	10	0	3	15	0
Bundled steel & shearings	2	18	0	3	10	0
Mixed iron & steel	2	17	6	3	7	6
Heavy cast iron	3	10	0	4	0	0
Good machinery for foundries		4	1	0		
Cleveland—						
Heavy steel		3	0	0		
Steel turnings		2	5	0		
Cast-iron borings		2	5	0		
Heavy forge		3	7	6		
Bushelled scrap		3	0	0		
Cast-iron scrap		3	15	0		
Lancashire—						
Cast iron scrap		4	5	0		
Heavy wrought		3	5	0		
Steel turnings		2	2	6		
London—						
Copper (clean)	54	10	0			
Brass (clean)	29	0	0			
Lead (less usual draft)	22	0	0			
Tea lead	20	0	0			
Zinc	16	0	0			
New aluminium cuttings	65	0	0			
Braziery copper	44	10	0			
Gun metal	39	0	0			
Hollow pewter	120	0	0			
Shaped black pewter	70	0	0			

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	95/-
Foundry No. 3	90/-
Forge No. 4	85/-
Mottled	80/-
Hematite No. 1	95/-
Hematite M/Nos.	94/-
Midlands—	
Staffs. common	—
„ part-mine forge	—
„ „ foundry	—
„ Cold blast	240/-
„ basic	—
Northants forge	70/- to 72/6
„ foundry No. 3	77/6 „ 80/-
„ basic	82/6
Derbyshire forge	75/-
„ foundry No. 3	82/6
„ basic	80/-
Scotland—	
Foundry No. 1	100/-
„ No. 3	95/-
Hematite M/Nos.	110/-
Sheffield (d/d district)—	
Derby forge	82/6
„ foundry No. 3	86/6
„ basic	—
Lincs. forge	86/6
„ foundry No. 3	86/6
„ basic	86/6
E.C. hematite	111/-
W.C. hematite	115/-

All d/d in the district.

Lancashire (d/d eq. Man.)	—
Derby forge	—
„ foundry No. 3	92/6
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
„ foundry No. 3	—
Summerlee foundry	112/-
Glengarnock foundry	114/6
Gartsherrie foundry	114/6
Monkland foundry	112/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (crown)	£11 to 12	0	0
Angles	12	10	0
Tees to 3 united ins.	13	0	0
Nut and bolt	10	0	0
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	11	7	6
Bolts and nuts, ¾ in. × 4 in.	22	0	0
Steel—			
Ship plates	10	0	0
Boiler plates	13	10	0
Chequer plates	10	10	0
Angles	9	10	0
Tees	10	10	0
Channels	8	15	0
Joists	10	0	0
Rounds & squares 3-in. to 5½in.	10	10	0
Rounds, under 3in. to ¾in.	9	10	0
Flats, over 5in. wide and up	10	0	0
Flats 5in. to 1½in.	8	10	0
Rails, heavy	9	10	0
Fishplates	14	10	0
Hoops	12	0	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	15	15	0
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ¾ in. dia	15	0	0
Billets, soft	7 5 0 to 7	10	0
Billets, hard	8	0	0
Sheet bars	7 7 6 to 7	15	0

PHOSPHOR BRONZE.

	Per lb basis.
Strip	1 3
Sheet	1 3½
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.

10% phosphor copper, £40 above price of B.S.

15% phosphor copper, £50 above price of B.S.

Phosphor tin (5%), £30 above price of English ingots.

CHARLES CLIFFORD & SON LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6½ to 2/0½
To 18 in. wide	1/7½ to 2/1½
To 21 in. wide	1/8½ to 2/2½
To 25 in. wide	1/9½ to 2/3½
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round—	
3/0 to 10. G.	1/8½ to 2/3½

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	27.32
No. 2 foundry Valley	24.00
No. 2 foundry, Birm.	18.50
Basic	26.96
Bessemer	26.96
Malleable	26.46
Grey forge	25.46
Ferro-manganese 80 % delivered	70.82
Bess. rails, h'y, at mill	40.00
O.-h. rails, h'y, at mill	40.00
Bess. billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	35.00
Wire rods	38.00
	Cents.
Iron bars, Phila.	1.96
Steel bars	1.70
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.70
Skelp, sheared steel	1.70
Steel hoops	2.40
Sheets, black, No. 28	3.15
Sheets, galv., No. 28	4.15
Sheets, blue an'l'd, 9&10	2.40
Wire nails	2.40
Plain wire	2.25
Barbed wire, galv.	3.05
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	32/6
„ furnace	22/6
Durham & North. foundry	28/-
„ furnace	23/6
Other Districts, foundry	27/6
„ furnace	22/6

SWEDISH IRON.

Bars, hammered basis sizes Basis price £24 to £25

	£ s. d.
Rolled Ordinary— Assortment ..	17 0 0 to 17 10 0
Nail Rods— Square, round and flats ..	
Keg Steel nom.	£38 to £40
Faggot Steel nom.	£30 to £32
Blooms— Single welded ..	£10 to £11
Billets— Single and double welded	£13 to £14

Pig-Iron—
Grey, white or mottled .. £8 to £8 15 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

Up to and incl. 6 in.

Gas ..	55%	Tube prices are now free.
Water ..	50%	
Steam ..	45%	

TINPLATES.

I.C. Cokes,	20×14, box	19/9
,,	28×20, ,,	39/6
,,	20×10, ,,	28/-
,,	18¾×14, ,,	20/-
I.X.	,	45/-
I.X.X.	,,	51/-
F.C.B.Y.	21×13⅝ ,,	37/6
C.V.B.G.	16½×15, ,,	34/9
I.C.W.	20×14, ,,	17/6
,,	28×20, ,,	35/6
,,	20×10, ,,	23/9
,,	18¾×14, ,,	18/-
Terneplates,	28×20, ,,	36/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
June 28	61	5	0	dec.	5/-
,, 29	61	12	6	inc.	7/6
,, 30	61	17	6	,,	5/-
July 3	62	10	0	,,	12/6
,, 4	62	10	0	No change	

Electrolytic Copper.

June 28	69	10	0	No change	
,, 29	69	10	0	,,	
,, 30	69	10	0	,,	
July 3	69	10	0	,,	
,, 4	70	0	0	inc.	10/-

Standard Tin (cash).

June 28	152	7	6	No change	
,, 29	151	17	6	dec.	10/-
,, 30	152	12	6	inc.	15/-
July 3	154	2	6	,,	30/-
,, 4	153	17	6	dec.	5/-

Tin (English ingots)

June 28	153	0	0	No change	
,, 29	152	10	0	dec.	10/-
,, 30	153	0	0	inc.	10/-
July 3	154	0	0	,,	20/-
,, 4	154	10	0	,,	10/-

Zinc Sheets (English)

June 28	36	0	0	No change	
,, 29	36	0	0	,,	
,, 30	36	0	0	,,	
July 3	36	0	0	,,	
,, 4	36	0	0	,,	

Spelter (ordinary).

June 28	27	12	6	dec.	2/6
,, 29	27	17	6	inc.	5/-
,, 30	28	5	0	,,	7/6
July 3	28	5	0	No change	
,, 4	28	0	0	dec.	5/-

Lead (English).

June 28	26	0	0	No change	
,, 29	26	5	0	inc.	5/-
,, 30	26	5	0	No change	
July 3	26	15	0	inc.	10/-
,, 4	26	15	0	No change	

THE
ARMITAGE WORKS Co., Ltd.
Manufacturers of
Highly Refractory Bricks and Blocks
FOR ALL PURPOSES.

SPECIALITIES:

CUPOLA LININGS.
Ladle Bricks for Siemens Ladles.
Chequer Bricks, etc., for Siemens Furnaces.
Gas Producer Linings.

GROUND GANISTER
for Iron, Steel, and Brass Furnaces. Forced Draught Brass Furnaces. Semi-Silica or Semi-Ganister Bricks. Silica Cement.

DEEPCAR, Near Sheffield.

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BARS, HOOPS, SECTIONS & WIRE
in IRON, STEEL, COPPER and BRONZE.
Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

REGISTERED TRADE MARK

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31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
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